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Researches on Proteins*

IX—The Action of Pepsin on the Protein "Sericin" of Silk[1]

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AN exact knowledge of the action of proteolytic enzymes on the proteins of silk is desirable both from a scientific as well as a practical point of view. It is a well known fact that the fibroin of silk is very resistant toward enzymes of tryptic or peptic nature, while the sericin is removed by the action of such ferments. As a result the degumming of crude silk by means of enzymes, [3, 4, 5, 6] has been recommended and applied in industrial practice.

Although there are numerous references in the literature describing the use of enzymes of tryptic nature for removal of silk gum, there is scarcely any mention of the action of pepsin on sericin. One of us[7] has shown that raw silk may be degummed by pepsin in its characteristic acid medium. Conte and Levrat[3] have mentioned the application of pepsin in the degumming of both wild and domestic cocoons. They reported only a preliminary experiment, however, and concluded that the use of pepsin for preparing cocoons for reeling is not practicable.

We have thought it of value, therefore, to make a study of the action of pepsin on commercial sericin under varying conditions. Such a study should yield data of twofold importance. First, it should give a means of comparing this protein with the better known proteins on which the action of pepsin has already been determined, and so add to our knowledge of the nature of sericin. Second, it should furnish information as to the practicability of applying pepsin to the degumming of silk industrially. The action of pepsin on sericin has been studied both when applied to the isolated sericin and to the gum in its natural condition on the silk fiber. In the latter form it has been particularly convenient for quantitative study, for the progress of the removal of sericin by pepsin was easily and fairly accurately followed by determining the loss in weight of the silk frissons employed as test material.

It is recognized that the loss in weight is a measure, not of the digestion, but simply of the solution of the sericin by the pepsin and hydrochloric acid. Moreover, the adsorption of both enzyme and acid by the silk fiber complicates the results further and renders their interpretation more difficult. Nevertheless, the data obtained seem to be of practical value, and even with these limitations allows certain definite conclusions to be drawn.

We have studied the influence of variations in temperature, time, enzyme concentration, and acidity, together with the behavior with different acids, and with variations in the methods of adding the enzyme.

Procedure and Apparatus

The procedure in general has consisted simply of immersing a sample of silk frissons of known weight in the acidified pepsin solution, allowing it to digest the desired length of time at a definite temperature, then rinsing the frissons in cold water, drying, and weighing. For this purpose, frissons, the waste from the reeling of cocoons, have a distinct advantage over the cocoons themselves, since they are free of chrysalides and also offer a larger surface for attack by the enzyme than do the matted fibers in the shell of the cocoon. Furthermore, since frissons comprise by far the greater portion of the waste

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* Paper VII. Shelton and Johnson, Jour. Amer. Chem. Soc. **47,** 412 (1925); VIII. Johnson and Daschavsky, Jour. Biol. Chem. **62,** 107 (1924).

[1] Constructed from part of a dissertation presented by Elbert M. Shelton to the Faculty of the Graduate School of Yale University, June, 1924, in candidacy for the degree of Doctor of Philosophy. An abstract of this paper was presented before the Division of Organic Chemistry at the Spring Meeting, A. C. S., Washington, D. C., April, 1924.

[2] Holder of the Cheney Organic Chemistry Fellowship, Yale, 1923-24.

[3] Conte and Levrat, Bull. Lab. d'Etudes de la Soie, Lyon (1903).

[4] Bietenholz, Textil-blatt **2,** 458 (1911).

[5] Hubbard, J. Am. Chem. Soc., **33,** 3043 (1911).

[6] Rohm and Haas, Farber Ztg., **30,** 81-82 (1911).

[7] Unpublished research of Treat B. Johnson

silk imported, a knowledge of the condition of the sericin on the frissons is of practical importance.

In order to obtain results of quantitative value all our pepsin digestions have been conducted under standard conditions. The drying of the silk, which is highly hygroscopic, was carried out with the greatest care by using an electrically heated conditioning oven provided with automatic thermostatic control to maintain constant temperature. For the pepsin digestions specially constructed incubators were utilized which were provided with special thermostat connections for automatically controlling the temperature. With our equipment it was possible to maintain a temperature constant within one degree for very long periods of time.[8]

In all experiments in which the influence of acidity was being observed the hydrogen ion concentration was determined colorimetrically by the method of Clark and Lubs.[9]

The Influence of Concentration of Pepsin on the Rate of Solution of Sericin

If sericin is a protein readily attacked by pepsin, and if the pepsin is not rapidly rendered inactive in any way, the rate of digestion should be approximately proportional to the concentration of enzyme, particularly as long as an excess of its substrate, the sericin, is present.

These are the conditions which might be expected to obtain in the experiments which follow, for if the whole protein material of the silk gum is homogeneous, then there is always a large excess of substrate present, since the loss in weight of the frissons seldom corresponds to more than one-half of the total sericin. The answer to the question as to the constancy of concentration of ferment is not so self-evident, yet it will be shown that in digestions extending over several days similar results are obtained whether the enzyme is added in successive instalments or in one lot at the start. Hence the disappearance of pepsin does not prove to be an important factor contributing to the results obtained.

In the light of this reasoning, it was expected that the loss in weight of the frissons should be very nearly proportional to the concentration of enzyme in the solution. It even seemed possible that a convenient means was offered for the determination of the activity of an unknown pepsin preparation. It was largely with this point in view that a series of experiments was first performed to test the rate of solution of sericin with varying concentrations of enzyme. To our surprise, no direct proportion was obtained. Although the results in these early experiments were less concordant than those obtained later after more experience with the method, they agreed sufficiently well to permit definite conclusions to be reached. The relation between the enzyme concentration and the loss in weight due to dissolved sericin was logarithmic, a tenfold increase in enzyme concentration serving only to double the quantity of sericin removed. It was at once evident that this could not serve as a sensitive test for the activity of a pepsin solution.

The following hypothesis seems most nearly to account for the facts observed:

(a) The protein, sericin, is not homogeneous, but is a mixture of proteins differing greatly in behavior toward pepsin.

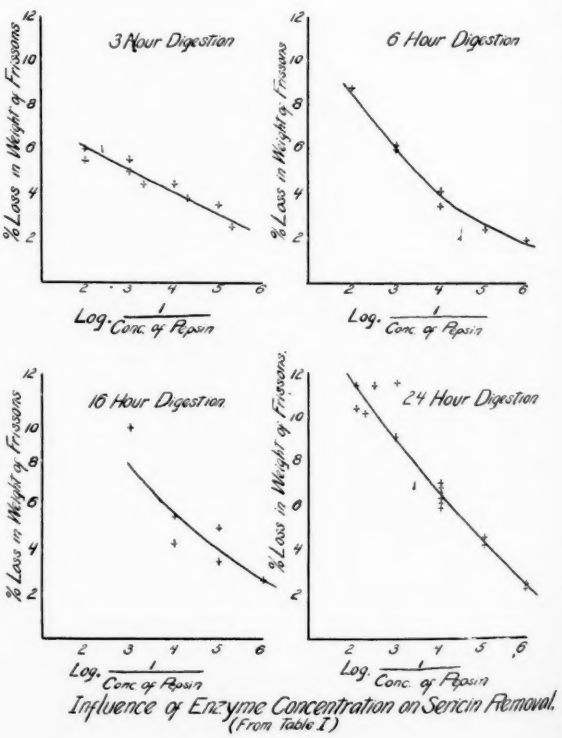
(b) The easily digestible portion is distributed throughout the less digestible material.

(c) A very low concentration of enzyme quickly removes the greater part of the easily digested sericin, resulting in an initial loss of weight out of all proportion to that obtained when a higher concentration of enzyme is used, or when the time of digestion is longer.

(d) The continued slow digestion after the first rapid attack may represent either:

(1) The digestion of more of the same easily digestible sericin fraction, but retarded by the slow rate of diffusion of the enzyme in through a layer of unattacked protein, or,

(2) The digestion of a different protein fraction which is more resistant to pepsin and dissolves at a slower rate.



Influence of Enzyme Concentration on Sericin Removal. (From Table I)

[8] The writers will be pleased to furnish diagrams and other details of the digestion units if such information would be helpful to other workers. The pepsin employed in our work was Armour's Scale Pepsin, U. S. P., of a fairly high activity.

[9] "The Determination of Hydrogen Ions."

(e) The ease with which sericin is removed from silk by washing and mechanical abrasion after a short peptic digestion is suggestive of a structure like that of a brick wall which crumples down when the mortar is disintegrated even though the individual bricks are unchanged.

Throughout this series of experiments the following factors were maintained constant: Temperature, 35.5-36.5 degrees; Medium, 50 c.c. of 0.2 per cent HCl per gm. of silk. The data obtained are given in Table I, in which enzyme concentrations are expressed in terms of the per cent by weight of the acid solution. This value, multiplied by 50, may be converted to the percentage with respect to the sample of frissons.

The curves plotted from the data above show a definite relation between the concentration of enzyme and the loss in weight of the sericin, in spite of the wide variation in results obtained under identical conditions. More consistent results were obtained in later experiments.

Progress of Peptic Digestion of Sericin with Time

Data showing the extent of digestion for a given concentration of enzyme over the range of 3 to 24 hour digestion periods is given in Table II. The curves plotted from the data of Table II show far better than the table the progress of solution of sericin at varying intervals after digestion has begun. After the first few hours of digestion the rate is seen to become much slower than at the beginning. The loss due to HCl solution without pepsin has not been plotted in this case, but it averages less than 2 per cent of the total weight of the silk during a 24-hour digestion.

TABLE 1.

Influence of Enzyme Concentration

Enzyme Conc.	Per Cent Loss in Weight of Frissons 3 hr.	6 hr.	16 hr.	24 hr.
1.0%	5.5	8.8	...	...
	6.0			
0.9	...	...	...	10.4
0.7	...	...	...	11.4
0.5	...	...	...	10.2
0.3	...	...	...	11.4
0.1	5.0	6.2	9.5	9.1
	5.5	6.1		11.5
0.5	4.4	...	...	...
				5.9
0.01	4.4	4.1	4.3	6.6
		3.5	5.5	6.9
				6.3
				6.1
0.005	3.8	...	...	...
0.001	3.5	2.4	5.0	4.6
			3.5	4.2
0.0005	2.5	...	...	...
0.0001	1.3	1.9	2.7	2.3
		3.1		
0.00005	2.6	...	...	...
0.00	2.6	...	...	2.7
	2.4			

The progress of the action of pepsin on sericin over longer periods was next investigated. Samples of frissons were digested for successive 24-hour periods. The temperature in these experiments was 39 deg. Cent., the medium, 25 c.c. of 0.2 per cent HCl per gram of silk, and the enzyme used corresponded to 0.5 per cent of the dry weight of the silk.

Three series of experiments were carried out.

1. The frissons were rinsed, dried, and weighed at the end of each 24-hour period of digestion, then immersed in fresh solution to repeat the digestion.

2. The frissons were rinsed at the end of each 24-hour period, then returned to fresh pepsin-HCl solution without drying and weighing. Several samples were started at the same time, and by removing and drying one at the end of each 24-hour period the series of losses was determined.

3. The frissons were given at the start all the pepsin they were to receive, 0.5 per cent by weight for each 24-hour period each sample was to be digested. The solutions were not changed during the period of digestion.

From the data of Table III and the corresponding curves the three series are seen to give similar results. Series I shows the least loss, indicating a retardation due to the repeated drying of the sericin for the purpose of weighing. The losses in Series II are higher, increased perhaps by a carrying over of adsorbed enzyme from one bath to the next. Series III starts out very much like II, then falls off rapidly, due probably to the combined effect of accumulation of digestion products, decrease in H-ion concentration, and destruction of enzyme.

The pH in Series I was always less than 2, varying from 1.2 at the beginning of a digestion period to about 1.4 at the end of 24 hours. In Series III the pH did not exceed 2.0 during the four days.

The curve obtained from Series I, by subtracting from the total loss in weight for each sample the loss due to the action of HCl alone over the same length of time, is especially significant, showing that after the second day the action of pepsin is very slight.

In the data obtained concerning the influence of time on the progress of removal of sericin by pepsin the difference between the initial and final rates of removal of gum is conspicuous, and points to the presence of two or more proteins of widely differing resistance to the action of pepsin.

The Influence of Hydrogen Ion Concentration and Effect of the Anion

This study was carried out with varying concentrations of the three acids: hydrochloric, acetic, and sulphuric. The data show that although the optimum pH is between 1 and 2, the influence of the anion is far

greater than the variation due to acidity. This is particularly evident in the case of acetic acid, which apparently combines with sericin to form a compound not readily dissolved by pepsin. A similar behavior is seen in the use of acetic acid to precipitate sericin from its aqueous solutions[11]. The check tests, using the corresponding strength of acid without pepsin, show great variation with the different acids, due partly to their varying capacity for dissolving the minerals present.

TABLE II

Rate of Enzyme Digestion

	Per Cent Loss in Weight of Frissons			
	3 hr.	6 hr.	16 hr.	24 hr.
In 1.0% pepsin sol.....	5.8	8.5	10.0	12.0
In 0.1% pepsin sol.....	5.0	6.0	7.6	9.4
In 0.01% pepsin sol....	4.1	3.8	5.5	6.8
In 0.001% pepsin sol...	3.2	2.4	4.0	4.4

TABLE III.

Influence of Time on Digestion.

	Series I		II	III
	Per Cent Loss		Per Cent Loss	
No. of 24-hr. Periods	With Pepsin	HCl Alone	With Pepsin	With Pepsin
1	6.1	1.7	...	...
2	8.0	2.7	9.4	9.1
3	9.7	4.2	11.5	10.5
4	11.0	5.3	13.4	10.7
5	11.6	5.7	...	...
6	13.0	6.8	...	...

Aside from effects due to peculiarities in the chemical nature of sericin, it was to be expected that pepsin would be most active in the presence of hydrochloric acid, with which it is associated in nature.

The digestions in this series of experiments were carried out under the following conditions: Temperature, 39 deg. Cent.; Time, 24 hours; Pepsin, 0.5 per cent of the weight of the silk; Medium, 25 c.c. of acid solution per gm. of silk.

In the case of hydrochloric acid the samples were digested for three successive 24-hour periods, while the treatments with sulphuric and acetic acid solutions were applied only once. At the time of making these tests, the colorimetric standards were available only down to pH2. Values less than 2 could therefore only be indicated by the sign "<2". Acid solutions of this strength, however, are quite satisfactorily expressed in terms of their normality. The data obtained are shown in Tables IV and VI. The mark, ", accompanying the number of a sample, indicates that the same concentration of acid was used in that case but without any pepsin.

Sample 1" in the acetic acid series, Table VI, shows an increase in weight due probably to combination with the acid. Such a combination may occur in all these experiments, being hidden usually by the relatively great loss in weight due to removal of sericin or minerals.

TABLE IV.

Digestion in Hydrochloric Acid.

First 24-hour period:					Per Cent Loss
	N. of	pH			Due to
Sample	Acid	Before	After	Total	Pepsin
0	0.120	<2	<2	5.0	3.75
0"	0.120	<2	<2	1.25	...
1	0.052	<2	<2	6.1	4.4
1"	0.052	<2	<2	1.7	...
2	0.013	<2	...	2.2	1.1
2"	0.012	<2	3.4	1.1	...
3	0.0055	2.5	...	2.0	0.65
3"	0.0059	2.3	4.0	1.35	...
4	0.0012	3.2	Putrefaction set in		
4"	0.0012	3.0	Putrefaction set in		
Second 24-hour period:					
0	0.121	<2	<2	2.5	0.8
0"	0 121	<2	<2	1.7	...
1	0.054	<2	<2	1.9	0.9
1"	0.054	<2	<2	1.0	...
2	0.012	<2	2.4	1.3	1.2
2"	0.012	<2	2.0	0.4	...
3	0.0059	2.2	3.4	0.87	0 6
3"	0.0059	2.2	2.8	0.23	...
4	0.0014	3.0	6.0	0.6	0 4*
4"	0.0014	3.0	5.4	0.2	..*
*Odor					
Third 24-hour period:					
1	0.052	<2	<2	1.7	0.2
1"	0.052	<2	<2	1.5	...
2	0.012	<2	2.0	1.9	1 2
2"	0.012	<2	<2	0.7	...
3	0.0057	2.3	2.8	1.2	0.9
3"	0.0057	2.3	2.6	0.3	...
4	0.0012	3.0	5.6	0.7	0.3*
4"	0.0012	3.0	5.5	0.4	..*
*Odor					

TABLE V.

Digestion in Sulphuric Acid

				Per Cent Loss
	N. of	pH		Due to
Sample	Acid	Before	After	Total	Pepsin
1	0.342	<2	<2	2.7	2.5
1"	0.342	<2	<2	0.2	...
2	0.069	<2	<2	2.7	1.6
2"	0.069	<2	<2	1.1	...
3	0.017	<2	2.3	2.4	1.5
3"	0.017	<2	2.8	0.9	...
4	0.0035	2.4	6.0	Putrefaction	
4"	0.0035	2.4	6.4	set in	

TABLE VI.

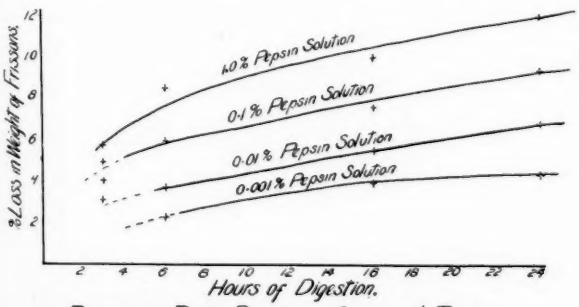
Digestion in Acetic Acid.

Sample	N. of Acid	pH Before	pH After	Per Cent Loss Total	Per Cent Loss Due to Pepsin
1	0.95	2.4	2.6	0.78	1.4
1"	0.95	2.3	2.6	—0.6	...
2	0.432	2.6	3.1	1.1	0.9
2"	0.432	2.6	3.0	0.2	...
3	0.086	3.0	3.8	1.5	...
3"	0.086	3.0	3.5	1.7	...

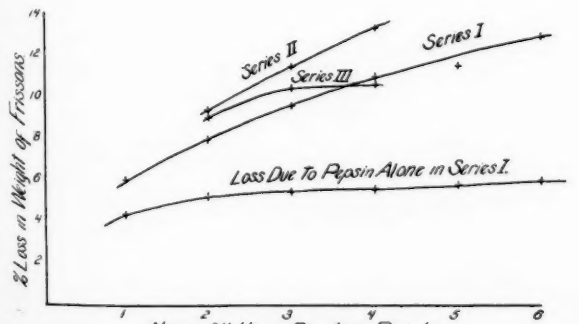
Optimum Temperature for Peptic Digestion of Sericin

The optimum temperature for the activity of pepsin depends very much upon the conditions under which the tests are made. This is best appreciated when it is considered that with increasing proteolytic activity of the pepsin, the rate at which it is destroyed also increases. Eventually the rate of destruction more than offsets the increased digestive activity. Hence it is evident that the optimum temperature may be much higher for a short period of digestion, and for low concentrations of acid, than for longer periods or more concentrated acid solutions.

The experiments on influence of temperature have been limited here to the following constant conditions: Time, 24 hours; Medium, 50 c.c., 0.2 per cent HCl per gram of silk; Pepsin 0.5 per cent of the weight of the silk.

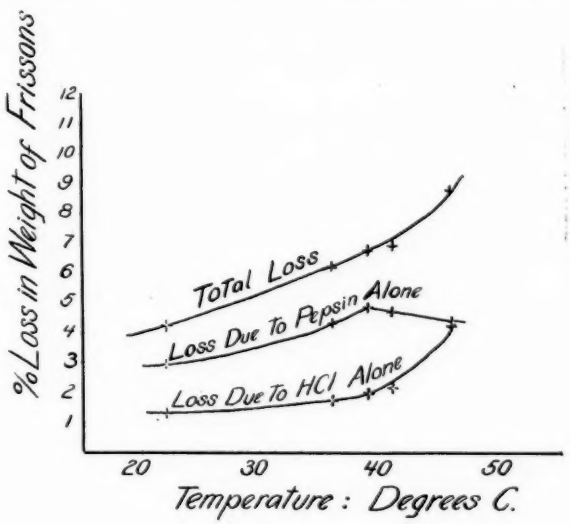


Progress of Peptic Digestion of Sericin with Time.
(From Table II)


% Loss in Weight of Frissons
Series II
Series III
Series I
Loss Due To Pepsin Alone in Series I.
No. of 24 Hour Digestion Periods.

Progress of Peptic Digestion of Sericin with Time.
(From Table III)

From the data of Table VII and the corresponding curves it is seen that while the total loss due to pepsin plus acid continues to increase as the temperature rises, the effect due to pepsin alone mounts to a maximum at about 39 deg. Cent. under the conditions of this experiment, then falls rapidly again as the temperature continue to rise. The ready solubility of sericin in the acid solution at higher temperatures is not surprising in view of its solubility in water alone at temperatures near 100 per cent.



Action of Pepsin on Sericin at Varying Temperatures. (Table VII).

Action of Pepsin on Sericin Isolated from Fibroin

The evidence thus far presented has indicated that a portion of the sericin is attacked little or not at all by pepsin. A study of the action of pepsin upon the frac-

TABLE VII.

Action of Pepsin on Sericin at Varying Temperatures.

Sample	Temp.	Per Cent Loss Total	Per Cent Loss Due to Pepsin
1	22°	4.35	3.0
1"	22°	1.39	...
2	36°	6.28	4.4
2"	36°	1.84	...
3	41°	7.00	4.8
3"	41°	7.20	...
4	39°	6.90	4.9
4"	39°	2.02	...
5	46°	8.90	4.5
5"	46°	4.39	...

tions obtained from purified sericin should settle this question conclusively. Moreover, experiments made with sericin in its natural condition on the fibroin were not of a nature suited to furnishing evidence as to whether that portion of the sericin which the pepsin does remove has actually been partially hydrolyzed or only dissolved unaltered. A systematic study of the action of pepsin upon the various protein fractions isolated from sericin is now under way.

SUMMARY.

1. The action of pepsin on commercial sericin has been determined under varying conditions of enzyme concentration, time, temperature, and acidity.

2. The behavior during peptic digestion cannot be accounted for unless the silk gum contains a mixture of proteins of different susceptibility to peptic attack.

3. The amount of sericin dissolved increases only in proportion to the logarithm of the enzyme concentration.

4. The rate of removal of sericin during peptic digestion is very high at the start, but is replaced after two or three hours by a fairly constant but much lower rate.

5. Hydrochloric acid is far more suitable for peptic digestion of sericin than sulphuric or acetic. The difference is largely due to the nature of sericin, since on other substrates pepsin shows a less marked preference for hydrochloric acid.

6. When digesting sericin for 24-hour periods in presence of 0.2 per cent HCl the optimum temperature is found to be 39 deg Cent.

7. The preliminary conditioning of frissons exerts only a slight effect upon the solubility of the gum in pepsin solution.

8. Very similar results are obtained whether the pepsin is added in one or several instalments.

ALL SECTIONS OF CHEMICAL INDUSTRY TO BE AT MONSTER BANQUET

Plans to accommodate a thousand guests are being worked out by the dinner committee of the Fifth Chemical Industries Dinner, which will be held at the Hotel Roosevelt during the week of the Chemical Exposition. It is fully expected that the attendance this year will exceed all previous records. The management of the Chemical Exposition, represented on the dinner committee by Charles F. Roth, has cleared the boards at the exposition for the evening of September 28, the date of the banquet. No meetings, lectures or other activities will be scheduled for that evening, since the biennial banquet inevitably attracts members from every branch of the chemical trades.

The following organizations are now co-operating with the dinner committee, headed by Ralph E. Dorland of the Dow Chemical Company: Manufacturing Chemists' Association, American Chemical Society, American Electrochemical Society, Chlorine Institute, American Institutte of Chemical Engineers, Society of Chemical Industry, Chemical Warfare Association, Synthetic Organic Chemical Manufacturers' Association, American Association of Textile Chemists and Colorists, American Ceramic Society, Compressed Gas Manufacturers' Association, Technical Association of the Pulp and Paper Industry. The dinner is being given under the auspices of the Salesmen's Association of the American Chemical Industry.

DYEING THE STANDING TREE

From time to time attempts have been made to color the wood of growing trees by injecting dyes at the base of the trunk during the period of the spring rise of sap. Heretofore only measurable success has been secured, as the colors obtained have not been fast. A German process, now under experimental trial in Maine, appears to have solved the problem. It permits the use of a wide range of dyes, and it is claimed that the resulting colors are not only permanent, but deepen with age. From the woods so colored many attractive novelties, as umbrella handles, door knobs, brush backs, buttons, and boxes, have been made.

The dye is distributed throughout the tree from a reservoir formed by boring a number of one-inch auger holes in the trunk, about four feet from the ground, and other holes through two or three of the large roots. The dye solution is placed in a 16-gallon container, hung on the tree about 12 feet from the ground, and connected with the reservoir and holes in the roots by rubber piping. A tree of 15 inches diameter breast high will suck up the contents of one of these containers in about 18 hours, and from 75 to 100 gallons of the dye solution are required to color completely the tree.

There is no question of the beauty or utility of the wood thus dyed, but the operation is rather expensive, as about six pounds of dye are needed for an average tree, and the proper shaping of the reservoir involves considerable time and labor.

The process seems to suggest new possibilities in the making of marquetry floors, novelties, wood products and furniture, and if these find favor, the process may afford a profitable outlet for stands of beech, birch and other hardwoods, for which no favorable market has previously been found.—Industrial Bulletin of A. D. Little, Inc.

The Fascist Federation of Manufacturers of Artificial Textile Fibers, on the one hand, and the National Union of Foremen and Workers in Chemical Industries, representing the operatives, have agreed to a 10 per cent wage reduction in the rayon industry to be deducted from the cost-of-living bonus where the workers are receiving such bonuses and in all other cases from the basic wage, reports Assistant Trade Commissioner E. Humes, Rome.

Proceedings of the American Association of Textile Chemists and Colorists

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RESEARCH AS A BUSINESS*

By DR. ROBERT E. ROSE
E. I. du Pont de Nemours & Co.

Man's search for information about his surroundings and about himself is as old as the race. He has been conscious of it since thought began. Only in degree, in precision, is our search changed in all the ages; now, in designating a very careful, very logical, extremely critical form of this activity of our intellectual life we have come to use the word research.

A dog searches for a bone, led by his senses and experience, influenced little, if at all, by what he has of reasoning ability. The morphologist searches for the reasons underlying the shape of the bone, the physiologist examines into its functions; both search with the aid of their highly developed reasoning powers and their work we call research.

THE VALUE OF THE INTANGIBLE

Whatever the details of the special case, research is a mental process superimposed upon the observation of facts. It is mechanical as well as rational, the two functions being equally important. Because it is a human activity it may be judged in terms of its usefulness as against its cost, cost being interpreted as human effort rather than mere money expended. However, being wide enough to embrace the infinite multitude of observable facts, whether these are found under natural conditions or as the result of the artificial conditions we call experiment, and also being a product of the trained imagination whose every guess is legitimate if in harmony with the facts, research is not easily reduced to analysis. How is it possible to place a value on a product as intangible as a work of art? How can we say whether the effort that went to the making of it is justified or wasted? It is no easier to judge the value of the products of the play of the imagination on the facts of existence. It is perhaps still harder to judge the value of the effort that goes to the collection of a mass of minute facts, each trivial as the hammering of a nail into a plank, yet each contributing to knowledge.

It is much easier to judge of visible products; thus when the architect and the artisan are finished, the result of the interplay of imagination and detail stands before us and we can judge it according to our likes and dislikes, to our feeling of its fitness to fulfill its purpose as measured against its cost. Because of its illusiveness, because of the enormous prizes it has brought to mankind, because of its value as a mental training, there is a tendency to be slipshod in criticizing research. Research is such an honest effort to achieve something of value that we are apt to condone the futility because of the good intention, or we may err the other way and condemn what is intangible because we cannot measure its use.

*A paper presented at the joint meeting of the Rhode Island Section of the American Association of Textile Chemists and Colorists and the American Chemical Society, April 29, 1927.

I propose to you that together we examine the modes and the cost of research and see if we cannot reach some conclusion regarding the enterprise as a function of human society. Research for our purpose is *organized effort to acquire knowledge regarding natural phenomena.* If we consider the research going forward in this country we can divide it roughly into four groups: First, that carried out as a part of the intellectual program of institutes of learning, which we may call academic research simply because of its home, not because of its character. Next we may place together the activities of institutions founded especially to advance knowledge by research. The work done in the industries we shall take for our third group. Finally, we shall make a fourth classification which we shall call professional research.

In all of this work the effort can be classified in this way: Materials and energy used, which include the cost of the surroundings in which the research is carried out, of the equipment, of the energy consumed in the shape of heat, light and power. Secondly, the man power this involves, not only the thinking brain conducting the research but also the manipulative functions of the research man or those assisting him in the research; this would include what the industrialist calls executive overhead as well as labor assistants. Thirdly, time, as a function of research, is really important, especially in the industrial field and should be considered in connection with all research.

The Cost of Academic Research

Academic research has been the fountain from which the most important knowledge regarding our surroundings has come. There was a time when research was unknown outside the walls of the institute of learning or the private home of the learned man. Nowadays the quantity of academic work is enormously much greater than ever before, and I think that we are not critical enough of it. Let us consider first of all the cost of research, which is obviously the most easily measured factor. In industry, where the cost of doing anything is checked very closely, it has been found that a trained research man whose salary is about $300 per month requires materials and manpower assistants costing $450 per month at least. That is to say, the research cost per hour, assuming a 200-hour month, is $4.00. The work done in the university costs less because, in view of the fact that the student doing his research gains by learning how he should approach a problem, he is paid nothing for the time he puts in, although he may work his way through by teaching part time for which he is paid.

Assuming, and I think this is not assuming too much, that the incidentals cost just as much in academic work as they do in the industries—that is, the working space properly furnished, heated and lighted, the laboratory facilities, the administrative expenses, the time of the man assisting the student—we reach a figure of approximately $2.25 per hour, plus the effort of the worker. If a doctor's thesis takes two years of nine months a year and the research occupies the candidate eight hours a day during the academic year, then we reach a figure of $6,480 as the cost of a doctor's thesis. Multiply this by the number of researches of this kind being carried out and we find that the people of the country are spending millions of dollars on academic research of this type alone. Any industrial firm spending such an enormous sum would be highly critical of the results obtained.

Training the Research Instinct

I aver that academic research is not properly scrutinized. We regard it so much as one of the steps in the course perfecting a student that we are apt to ignore its intrinsic value. Now I am not going to argue that the training the student gets is not of primary consideration, although I think that it is less important than it is sometimes thought. I am also willing to concede that the student is doing his first research work and is therefore much less competent than the older research worker of the industry. Yet when everything is taken into account it seems to me that we could get very much more from the work than we do.

A destructive criticism is easy. On the constructive side I would suggest that research problems can be chosen only by men who have a research instinct; by men who are following up a lead which may mean a real advance in our knowledge. Such men are rare and therefore my first change would be in limiting the number of academic institutions in which research is done for advanced degrees. This calls for a great unselfishness, while I am afraid that inevitably selfishness is characteristic of the attitude of the academic body to its students —perhaps unconscious, but arising out of the situation. Thus, if a senior has shown great promise it is natural for the graduate school to try to keep him when they should send him to another university where he will find the man best able to lead him on in the lines which he has chosen. Of course, if the graduate school of his own university can conscientiously hold him because they believe they can give him the best that there is in the country, then they are justified in doing so; but they should be extremely critical.

In furthering this improvement I should like to see the undergraduates acquire some critical faculty of their own, as they do in Europe. This, I believe, can be brought about only by getting away from the idea that the university course is merely a finishing up of an ordinary education and by adopting the European belief that

it is a great advantage to move from one university to the other, which can be done there without loss of effort. In that way the student encounters different presentations of the same subject and he learns to acquire a cer- discrimination which seems totally lacking in the student's attitude to research in this country. When it comes time for him to do the doctor's work he should be quite clear in mind that such and such a university, because of the research ability of the professor in charge of a single branch, is the only place in the country for him to go. Since he can work his way about as easily in one place as another there seems no reason why we should not be able to foster this procedure.

I should like to see a definite stand taken against the point of view that because a conscientious young instructor has been promoted on account of his teaching ability to an assistant professorship he is therefore entitled to experiment on graduate students. Unless the young man has, by his own work, established the intrinsic merit of his attitude to research and his capacity for initiating research he should not be allowed to act without the advice and direction of a maturer research man. On the other hand, it should be recognized much quicker than is often the case when the young man is a more brilliant research worker than the head of the department, and then the head of the department should be honest enough to turn over his best students to the assistant professor.

Do We Overburden the Research Man?

From my experience of the industry and of academic research I do not believe it possible for a man to function at the same time both as an executive of a large establishment, as a teacher and as a director of research. I do not believe it can be done except by a great sacrifice of the highest attribute of the man, that most delicately balanced function of the mind which is the guiding spirit of research. Therefore, I should like to reiterate what has been said so often, both by myself and others: that we should not reward research by executive responsibility and that we should relieve the true research man from the round of ordinary teaching and let him build up a research school fed by students from all over the country sent by his colleagues and attracted by the well-informed opinion of the student body.

I know that we argue for the complete independence of the research man and yet I should like to see a more collective effort made to unify the research effort of the country. A young teacher, having carried out a small research problem which may have been a very secondary feature of a larger problem given him by his research master, starts in to do research for himself. His mind is led, very naturally, to some little detail arising from the work he has done. That is good for him, but his view is too narrow and he is quite remarkable if he does not overestimate what is really quite trivial.

If we carried our national effort further, if we placed before our research men problems which might appear worth attacking because of their relation to still larger, more important problems, I believe that these men would be tolerant enough to avoid stifling a new line of thought pursued by a younger man. And in this way we should have the advantage of far less wasted effort than at present, because, I think, we stretch much too far our sympathy with each little piece of research, which is, after all, but one more pebble in the palace of knowledge. We are too likely to encourage the collection of pebbles to put around the flower borders and grounds, instead of hewn stone to build into new wings.

Even assuming an excellent subject for a doctor's thesis, it still may remain true that there is a waste. In industrial work the importance of *time* is stressed constantly; perhaps it is overemphasized. In academic work we have accepted the doctrine that accuracy is so important and that the chances are so great of accuracy being sacrificed if any effort is made to speed up the work, that we should lean the other way. We should remember that the real leaders of research, while they may have taken a great deal of time before they felt their results sure enough to present them to their colleagues, did actually work very fast in getting the evidence together. I remember that when his friends urged my old teacher Wislicenus to hurry up his publications for fear of losing his priority he paid no attention whatsoever but went along gathering the data necessary. At last he would publish and his paper would, perhaps, fill a whole volume of the Annalen. His contribution was so finished, was so profound, that the matter of priority ceased to bother anybody, but from this it would be quite unfair to argue that he wasted time. Actually he worked very rapidly and proceeded from step to step with a certainty that was most economical of effort.

Teaching the Young Worker Economy

Of course, the young research man on his first problem is bound to waste a lot of time, but let us show him how to economize his effort; let us, above all things, point out to him that his loss of time, rather than being the proper attitude toward the work he is doing, is something which marks his immaturity. A young man may be able to observe only one reaction at a time, whereas a man with experience and a higher critical faculty may undertake six parallel experiments with success; but let the young man do as much as possible and do not encourage him to think that it is the essence of research to watch the pot boil.

In this connection I think that it would be wise to de-

vote a little more of the money available for research work to amplifying the apparatus available and to furnishing manual help so that dish washing might not be a necessary part of the research worker's time consumption. I always remember the contrast that was presented in the attack on water analysis by the regular class in this subject at one of the universities at which I taught and the Government analyst on the same work. The students carried out about two complete analyses in a semester, giving six hours a week of laboratory time to it. The expert carried out, as I remember it, something between ten and fifteen analyses in parallel and was busy every instant of the time. It would be impossible to expect such a high technique from students, but it is reasonable to demand the best they can give.

In substance, then, my criticism of academic research is that it fails of being what it should because the subjects chosen are not well selected, the time spent is out of all proportion to the results, and the effort is not sufficiently co-ordinate.

My criticism I want taken as constructive because I am, in reality, thoroughly in accord with the belief that academic research is fundamental to the success of the race. It is on this account that I am glad to think that, owing to the realization by those directly engaged in the industry of the importance of the work done by their own research men, we shall see eventually a very great encouragement of basic research by men of wealth. Already such men have found it possible to express their interest by giving magnificent laboratories, but they have not yet found a means of doing that which they realize is still more important—fostering the man of genius. Obviously, it would only be the part of stupidity to feel that magnificent walls are a more permanent contribution and a fitter monument than a share in deeply significant work.

Sharing the Profits of Research

The rich man knows well that were he to succeed in raising the status of the scientist he would be wonderfully rewarded. At present there is no very obvious way of doing this. Unquestionably our great research men should be able to look forward to earning salaries of $25,000 and over. We must admit that our society is built up on success as measured in terms of money, and therefore a great man should have the satisfaction of independence, together with the stimulation of feeling that society has awarded him a position of success.

It is true that industrial scientists are not paid any such munificent salaries, though they are placed in a position to participate in industrial success to an extent unknown in academic circles. If a university were making 25 per cent clear on its investment and the merit of this financial success were traced in large part to special men on the teaching staff whose outstanding genius drew the large student body, it would be only fair to share the profit with them to some extent. Actually this is practically what was done in Germany and it resulted in the social status of the professor being all that he could ask and made him relatively rich. It also introduced the factor of competition among professors, which is most excellent though practically unknown in this country. How can we make it possible that our great scientists should realize such success?

I do not believe in tying up large endowments with particular chairs because frequently the surroundings may be such that they prevent the best man available from being secured, or the move essential to accepting the new chair may tear him from friendly surroundings which contribute largely to his success as a scientist. Again, I say, I believe in extremely handsome salaries as a reward of enlarging the domain of our basic knowledge and this irrespective of the apparent utility of the discoveries. Surely we may count on enlightened response to this problem from the wealthy who have before them the admirable example set by Nobel who, you will remember, stipulated that his prizes should not be awarded were there no worthy recipient found

Industrial Research

Industrial research I define broadly as all research paid for by the owners of our industries, research being taken to mean anything out of the ordinary in the way of control work as well as such utilization of basic knowledge as is necessary for greater economy in production. I am willing to call research even that type of work which is no more than intelligent works control.

Research is just as imperative to the existence of a large producing corporation as it is to the growth of science. That fact is generally recognized in this country. It is not so taken for granted, but is no less true, that research is equally as important to the small concern. Unfortunately the small industrial unit does not feel that it can afford research. Actually the stockholders would find it a most profitable investment were they to plow back some of their profits into research. However, there is every need for caution in this matter. Usually it is true that the more isolated the research chemist, the maturer he ought to be. I am a thorough believer in the genius of youth, but as an independent research worker in surroundings which limit him strictly and force a great deal of routine upon him as well as a necessity for impressing owner and manager, the very young chemist cannot compare with one of many years' experience.

It follows, then, that the smaller the company, the more experienced should be their chemists, but good, experienced men are necessarily more expensive than young ones, and the small company deciding to choose a research

chemist usually picks one unsuited to its needs. They will pay a man $175 a month when they need the experience that makes a man worth $125 more than that. The extra salary would make the whole outlay a very much better investment if they could but be brought to see it; an investment that would carry itself easily.

Another cause of trouble and unproductive expense is that directors or owners, having but little knowledge of the real meaning of research work, often put the man they choose into a position calling for a great deal of routine, so much that real research is out of the question. This discourages the chemist and disappoints his employers, who consider research a failure because they have had only bills to pay and can see no return.

In the case of large corporations conditions are very different. They can afford research on a very generous scale. Such research has to pay its way; but this does not mean that directors are blind to the value of research, even though there is no immediate return from it. It means that the money of the stockholders must be spent profitably under the conditions existing at the moment. It means that the research must have a direct purpose in view; it is not enough that it should extend our knowledge, even in that field of enterprise in which the industry grows.

Work with a Purpose in View

It is evident that herein lies the most difficult problem of the research director. In a large establishment he must delegate much of the detail to the senior men under him, but the choice of what is done must rest with him. He must decide, in co-operation with his most mature men, whether a problem should be taken up fundamentally or empirically. Often a piece of work will be productive much sooner and will cost much less if it is treated from basic principles. For example, it may be that the establishment of the relation between certain fundamental physical constants and observed results, when once correlated, will enable the research man to formulate a general statement covering all cases in point and enable him to go ahead much more quickly than were he to try to find the most suitable material for his purpose by trial.

On the other hand it may be very much cheaper, though essentially less satisfactory, to learn by trial. It all depends on the problem in relation to the industrial requirement. This is the very striking difference between *academic* and *industrial* research. It is a difference the young man, fresh from the university, where he has been drilled in the importance of fundamentals, is very apt to ignore, with the consequence that he thinks ill of research done as he finds he is told to do it, he grows careless or he insists on going his own way, and gets into trouble in any case.

In a sense research that cannot go to fundamentals and yet must bring results, is more of an art than a science. It is for just this reason that it calls for a very high order of scientific training; otherwise it will degenerate into unproductive pottering, that worst curse of the research laboratory. It takes patience and a good training to carry out work with the utmost elaboration, but it takes patience, training, experience and a certain type of sagacity if a man is to use his faculties as a guide and follow the scent without stopping to make sure of anything.

In Praise of Industry's Efforts

I think that on the whole the work done by the industries, as far as subject matter is concerned, is fairly satisfactory, more so, perhaps, than academic research. Every now and then we run across some absurdity carried out by a research worker who has forgotten his elementary chemistry and physics and decides to prove or disprove some fact by experiment when he should be able to reason it out with pen, paper and a textbook. I think also that on the whole industry utilizes its manpower satisfactorily. I think that the rewards coming to the research worker in industry are on the whole adequate.

If I have any criticism it is that the industrial concern does not reward sufficiently the acquisition of experience that is invaluable; by that I mean the knowledge acquired by a good man, after ten years as a specialist, cannot be replaced unless the firm is lucky enough to have a subordinate growing up to fill the position. Such a man should be made comfortable, should be kept satisfied, in order that he may do his best. I am sure that the employers of research men are not sufficiently alert to the importance of preventing occupational stagnation if good research is to be done. Every research man should have a chance to get away from his working surroundings and meet other scientific men at least once a year, without sacrificing his vacation. He should be encouraged to develop as a man of culture as well as a specialist, and on this account should he desire an extension of the two weeks vacation in order to travel, such a request should be given sympathetic hearing. Unless a research worker is growing in all directions mentally, he is not fully efficient.

Rushing the Program

Turning to the time factor I think it fair to say on the whole that the industry is apt to force research to be more hurried than is wise; but I am rather slow to make this statement because after considerable experience I realize that there are a great many factors other than the mere acquisition of the information which must be taken into account.

Let us say that a research laboratory has developed a method on a small scale for making a product which

promises to be very profitable. The directors of the company believe that by an expenditure of a million dollars and provided they can begin production in six months, they can obtain a handsome return on their investment. Plans for the plant must be rushed, but plans depend, in the case of chemical plants, on the equipment to be housed, and the equipment depends on the details of the process as carried out on a large scale. Naturally the research necessary to put the process into shape for large scale production is rushed to an unhealthy extent, and in consequence it is not unusual to find that a good deal of the equipment has to be scrapped later. But this does not mean that the hurry was unwise. It may be that in the long run the stockholders benefit more by the speed with which the work goes forward, even counting the loss of the equipment, than they would if time were taken to put the process into excellent shape. One must remember that to do a thing perfectly from one point of view is not necessarily the best commercial procedure.

Of that work which is done in the research institutions of the country I am unable to say much because I have no direct experience. I believe that an institute like that founded by Rockefeller is one of the nation's greatest assets, largely because its contributions to medicine are international and tend to draw together the peoples of the world. As long as such institutes are in the hands of scientists of genius they will be of the utmost importance to us. They are expensive only when looked at from the narrow point of view of dollars and cents.

The professional men of this country are doing a great deal of good research. They do this by observing carefully during their contacts with conditions as they find them. They are taking the place, to some extent, of the rich amateur who at one time was the large contributor to scientific progress. The difference is that the work of these men of to-day is more directly related to the practical use of science than was the work of men like Cavendish. Work of this kind carried out by physicians may flower into research work as richly endowed as that carried out at the Mayo Institute, which has become a center of biological chemical research.

In looking over the whole field of research in this country we should be satisfied that we are putting so much effort into so useful an endeavor. We should not, however, be satisfied with things as they are, and research, like everything else, must grow, must develop, if it is to mean all that it should to us. What we should strive to bear in mind is the truth of the statement made by John Milton:

"Our greatness will appear
Then most conspicuous, when great things
of small,
Useful of hurtful, prosperous of adverse,
We can create."

JOINT MEETING OF THE PIEDMONT AND SOUTH CENTRAL SECTIONS

The midsummer meeting of the Southern Sections of the American Association of Textile Chemists and Colorists was held at the George Vanderbilt Hotel, in Asheville, N. C., on Saturday evening, July 16, 1927. This was a joint meeting of the Piedmont Section and South Central Section. There were ninety-five members present at the banquet and 115 members present at the meeting.

On Saturday afternoon a baseball game was played, in which the single men beat the married men by a score of 6 to 5. There were not enough single men present to form a team and the married men loaned them some of their men. It was said that by help of the married men on both sides the single men won the game.

Prizes were given to the players on both ball teams after the banquet, with appropriate remarks by David Clark, of the Southern Textile Bulletin.

During the business session of the meeting, R. W. Arrington, of the Piedmont Section, was elected to serve on the committee for the nomination of officers of the parent association. Tom Taylor was elected to serve on the committee representing the South Central Section. Dr. E. H. Killheffer, vice-president of Newport Chemical Works, Inc., and vice-president of the association, was present at the meeting.

Papers were presented as follows:

T. C. King, superintendent of dyeing, Cramerton Mills, Inc., Cramerton, N. C.: "The Dyeing and Finishing of Celanese."

John L. Crist, general manager of Beaver Chemical Corporation, Damascus, Va.: "The Manufacture of Sulphur Colors."

A. R. Thompson, Jr., Southern manager of Rohm & Haas Company, Inc., Charlotte, N. C.: "The Uses of Hydrosulphite in the Textile Industry."

Carl C. Poindexter, chemist of Chatham Manufacturing Company, was absent from the meeting and his paper was not delivered.

The papers presented are published below.

The Dyeing and Finishing of Celanese

By T. C. KING
Cramerton Mills, Cramerton, N. C.

Judging by the amount of literature now available for one interested in the dyeing and finishing of Celanese we would at once think the subject had been exhausted, but such is not true. The study of a fiber offering to the dyer unlimited application of his art needs never be exhausted. Differing from other rayons in its chemical make-up enhances its value as a decorative fiber and as such it was first used. Since its inception as a commercial fiber

improvements have been made in Celanese as to its chemical nature, and we at present use it not only as a whole but in combination with all other fibers.

A bit of history of the development of cellulose acetate may prove of interest. At the mention of the fiber Celanese our minds at once think of our English brothers, they being the first to produce a synthetic fiber for practical use in textile industries. By following experiments by Schutzenberger and Frankimont, neither of whom were able to make a success of the cellulose acetate, it fell the fortune of F. G. Miles, of Boston, Mass., to bring out the first successful soluble cellulose acetate. After repeated efforts at trying to interest American manufacturers he sold his rights to the Bayer Company. They brought out a cellulose acetate fiber in 1907 which enjoyed but limited sale. Being a single acetate the dyers were never able to produce shades fast for the trade, which limited its application in the textile field.

The Origin of Celanese

Following the World War several plants whose business had been furnishing for the airplane industries a dope for wing coverings, left without buyers of their products, turned quickly to the production of cellulose acetate fibers for which they were equipped with a few minor changes. This was in 1920 and since that time we find a steady increase in the consumption of this fiber. It is now a tri-acetate offering ease of applying colors that the first acetate did not have, and with improved colors the dyer has the same leeway in producing pleasing shades as with other fibers. This new and improved fiber, along with the latest type of cellulose acetate dyes, has so broadened the field of use alone and in conjunction with other fibers that the dyer must of necessity make a careful examination and devise ways whereby he can produce a fabric suitable to the trade.

A casual examination would lead one to believe that it was very closely related to pure silk. A closer observation leads one to think it a member of the rayon family, of which we are familiar; but really it is a fiber outside of either of the mentioned products. The members of the rayon family, being regenerative cellulose, differ both chemically and physically from the acetyl cellulose, or Celanese, which therefore should not be classed as a rayon but as a new fiber.

The early attempts to dye Celanese led to confusion in most instances, and from the earliest date study has followed wherever this new fiber has been used as one of the textile fibers. Being soluble in several organic solvents, a characteristic unlike most other fibers, has had its effect toward the solving of its attending faults. Celanese is water repellant to a greater extent than any of the other artificial fibers. Close analysis shows that its water-absorbing qualities equal only one-third to one-half of the moisture contents of other fibers. An excess of heat in the treating of Celanese either in scouring or dye baths, leads to a loss of luster and feel. This condition then limits the application of some dyes, and also, to an extent, the cleaning and bleaching.

Preparation for Dyeing

The preparation of Celanese is not attended with very many troubles before dyeing. The water, mechanical equipment and methods must of a necessity be worked out by the individual for his particular needs. There are general instructions, which if followed, will give excellent results. The Celanese Corporation of America have, through their laboratory, issued for the convenience of their customers, folders containing information no user of this fiber should be without. Quoting from their information furnished and of other information where applicable, we will carry several lots through the processes attended upon desired results.

It may be well to state here that with the use of certain inorganic salts with strengths of 10 per cent or less, boiling may be carried out without the attending loss of luster or feel. With the use of ammonium sulphate it is possible to prepare the mixed cotton-Celanese, also to pretreat wool-Celanese mixtures satisfactorily. This use of inorganic salts enables the dyer to produce satisfactory results.

The scouring of Celanese is best carried out as follows: 1 to 2½ grams per liter of good neutral olive oil soap, 1 to 2½ c.c. per liter of Turkey Red oil or Celasour, a product especially prepared for this work by the Celanese Corporation, and 0.5 to 1 c.c. per liter of ammonia, in soft water at a temperature of 170 deg. Fahr. By treating the Celanese in this solution you will gain in most cases a very clean fiber with exceptions as to oils and foreign substances picked up in manufacture or in handling. This wetting-out method is applicable to cotton, providing it is in good shape. Where stronger treatment is wanted for the attending fiber, quite frequently a light soda boil is given. This treatment may be prolonged for an hour or so without deleterious results. If the treatment just given does not give the desired results, use with discretion agents offered to work in conjunction with Celanese in the scouring of other fibers. All agents offered are not without some merit, but there is great danger in delustering or impairing the quality and feel of Celanese. Particularly where chlor hydrocarbons are incorporated into the agent extreme care should be exercised.

Dyes for Celanese

When the color chemist recognized Celanese as an individual fiber, then it was that he was able to bring out

dyes suitable, giving tinctorial value with all-around fastness to the greater number of color destroying agents. Among the very earliest of the color manufacturers to recognize the possibilities of Celanese was British Dyes-Ltd. They were able after considerable work to evolve a shade range satisfactory as to coloring properties. These colors have been on the market some time now, and are familiar to you as the Celanese SRA colors. These colors are normally insoluble in water, but by colloidal means they become soluble and are miscible in water.

The letters SRA represent the letters of the colloid, which is in reality an oil, sulpho-rincinoleic-acid oil. This oil has the pleasing properties of furthering the dispersion of certain of the organic bases to such a state as to lead to the thought that the mixture is in solution. This apparent solution can be further treated with caustic soda or ammonia with hot water, and greater dispersion will be brought about. Since the first method evolved the use of acid salts for coloring media, we see at once the discrepancy bound to be when the acid to be used as a solvent agent was hydrochloric. This brings about no homogeneity of the dyes in the bath, leading to bad or offshade work.

The manufacturer receives the Celanese in an oiled condition, this condition enabling him to process, wind and reel it without large amount of waste. Then upon arrival of the product to the dyer the foregoing operations are very simple and easy compared to the problems the dyer has to solve.

[*Mr. King offered to the assembly practical dyeings showing the finished goods after the different processes of dyeing and finishing of the combined fibers used in these samples. These samples were practical mill dyeings showing the feasibility of the latest processes. He ended up by showing samples of all vat dyed Celanese and cottons, with special anthraquinone dyes made for this purpose.*]

Uses of Hydrosulphite in the Textile Industry*

By A. R. Thompson, Jr.
Rohm & Haas Company

All of the sulphur compounds have a very extensive use in the textile industry. This paper will be confined, however, to a discussion of a very interesting group of sulphur compounds, such as hydrosulphite and various sulphoxylate compounds. There are about four or five of these which we will consider very carefully, not only their actual uses in the textile industry, but also their physical and chemical properties as well. There are probably a good many undiscovered uses and interesting reactions not yet known to these compounds, and the writer feels that if a complete discussion of the properties of hydrosulphite and related compounds is given, some listener or reader may be able to put them to a new use in our great industry.

*Paper presented at the joint meeting of the Piedmont and South Central Sections of the American Association of Textile Chemists and Colorists, Asheville, N. C., July 16.

Sodium Hydrosulphite Concentrated

Physical and Chemical Properties.—Sodium hydrosulphite is a white crystaline anhydrous powder, having the formula $Na_2S_2N_4$ and a molecular weight of 174. It is completely soluble in water and alkalies. A water solution of this product is not very stable and breaks down into other sulphur compounds, such as sodium sulphite, sodium thiosulphate, sodium bisulphite and free sulphur, and the solution becomes very cloudy and gives off a very sharp odor, characteristic of the decomposition products of hydrosulphite. Acid solutions of hydrosulphite break down instantly into the above-mentioned compounds. However, alkaline solutions of hydrosulphite remain fairly stable for several hours if kept cool and away from the air. Heating causes hydrosulphite solutions to break down more rapidly. There is always an oxidizing reaction going on when hydrosulphite is dissolved, even though the solution is protected from the air. This reaction is called auto-oxidation and is explained by the following equations:

$$2Na_2S_2O_4 \rightarrow Na_2S_2O_3 + Na_2S_2O_5$$

Sodium Hydrosulphite — Sodium Thiosulphate — Sodium Meta-Bisulphite

If caustic is added to keep the above solutions alkaline, the same reaction takes place only very much slower, and the bisulphite breaks down into two molecules of sodium sulphite as follows:

$$Na_2S_2O_5 + 2NaOH \rightarrow 2Na_2SO_3 \quad H_2O$$

Meta-Bisulphite — Sodium Hydroxide — Sodium Sulphite — Water

Hydrosulphite is very liable to oxidize when allowed to come in contact with air, and this reaction is especially rapid in a water solution of hydrosulphite, according to the following equation:

$$Ha_2S_2O_8 + O \rightarrow Na_2S_2O_5$$

Hydrosulphite — Oxygen — Meta-Bisulphite

Hydrosulphite is a very strong reducing agent, and this property makes it very valuable for certain uses in the dyeing, bleaching and stripping operations. Hydrosulphite is generally put on the market, having a strength of 88 to 92 per cent $Na_2S_2O_4$.

This product has been known by the following trade names: Blankit, which was the pre-war German name; hydrosulphite and Lykopon are the American names.

Hydrosulphite is used very extensively in reducing Indigo and other vat colors which are becoming so popular because of their fastness. It is also used for stripping direct cotton and acid colors from cotton, wool, silk, rayon and mixed materials in the raw stock, yarn and piece goods; in the bleacheries as an antichlor; for springing vat colors back to their original shade after the chlorine bleach, and in laundries for removing certain ink and fruit stains, etc.

Uses of Hydrosulphite in Vat Dyeing.—There have been so many papers prepared on the use of hydrosulphite in reducing Indigo and vat dyes that it hardly seems necessary to spend very much time on this well-known use, except to say that hydrosulphite in conjunction with caustic soda is a very important chemical in controlling the shade and evenness of these colors. The evenness obtained in the dyeing of all colors on textile fabrics is largely dependent on the complete solubility of the dyestuff. In the application of direct cotton colors we often add small quantities of soda ash to increase the level dyeing properties of certain colors. Soda ash is added and oftentimes caustic soda in conjunction with sodium sulphide in the dyeing of sulphur colors to obtain level dyeings. In the application of vat colors we depend upon hydrosulphite to render these colors soluble, and if the hydrosulphite is not present in sufficient quantities to maintain a perfect state of reduction throughout the dyeing, part of the vat colors will go out of solution and give uneven shades. The hydrosulphite must be of approximately the same strength every time it is used in a definite formula, in order to produce the same shade on every dyeing. Small differences of 2 to 3 per cent in strength are not sufficient to cause a very great difference in the shade unless the amount of hydrosulphite used in the formula was on the very lowest limit. In making solutions of hydrosulphite to be used in reducing vat dyes very great care must be taken that the hydrosulphite solution is analyzed very carefully and the proper amount figured back to the formula for the particular dyeing which is to be made. If the hydrosulphite is weak or there is not enough added, the dyeings will be uneven, and much of the vat dyestuff wasted; if the hydrosulphite is too strong or there is too much present, you will not get sufficient exhaustion of the bath and the resulting shades will be light. There must always be a slight excess of hydrosulphite present during the vat dyeing operations. The presence of an excess of hydrosulphite is easily determined by inserting a strip of Indanthrene Yellow paper in the dyeing solution. This paper is reduced to a blue color when there is an excess of hydrosulphite present. (See paragraph under sodium sulphoxylate formaldehyde, "Use in Dyeing Vat Colors," for further information regarding the stability of a hydrosulphite bath for dyeing vat colors.)

Hydrosulphite in Stripping.—Hydrosulphite is used very extensively for stripping hosiery, underwear, raw stock, yarn and piece goods that have been dyed too heavily or unevenly with direct cotton colors, acid colors, etc. The material to be stripped is usually cleansed from grease and dirt with some mild alkali such as 3 to 5 per cent of ammonia, 1 to 3 per cent of soda ash or soap at 180 to 200 deg. Fahr. About 3 to 5 per cent of hydrosulphite is then added to the stripping bath containing the ammonia or soda ash, etc., at 180 to 210 deg. Fahr., and the stripping operation is carried on for fifteen to sixteen minutes, depending on how much color is to be removed and also on the nature of the color. The hydrosulphite is added directly to the bath without previously dissolving it when the temperature has reached 180 to 200 deg. Fahr. In stripping hosiery, the addition of 3 to 5 per cent of a good soluble oil aids in the stripping and also serves as a lubricant to the silk fibers, thereby preventing chafing. The use of different alkalis will depend on the fiber being treated. For instance, when stripping silk, wool or rayon material, ammonia is to be preferred, because it does not have the harshening effect that the stronger and less volatile alkalis possess. Soda ash and caustic can be used in stripping cotton and linen material, but it must be washed out thoroughly after the operation is completed. The addition of about one-fourth of 1 per cent of anthraquinone paste to the hydrosulphite stripping bath will aid in the reduction of certain scarlets, red and cordovan colors when the above formula does not give satisfactory results. There are a few yellows, such as Yellow WB, Yellow NN, Chloramine Yellow, etc., which cannot be stripped by any present known method. After stripping, the material is simply washed with cold water and finished or redyed.

Hydrosulphite in the Bleacheries.—About 8 to 16 ounces of hydrosulphite per 100 gallons of water serves as a very efficient antichlor after the chlorine bleach, and also springs the vat colors back to their original shade where they have been greened by the hypochlorite. The addition of a small amount of soda ash to the springing bath will stabilize this solution and will tend to prevent certain gold and orange colors from being overreduced. Quite often when springing material containing blue and gold stripes, the blue will reduce to its original shade immediately, but the gold will become a dull brown and will not return to its original bright shade for several hours. The addition of a small amount of soda ash to the spring bath will prevent the overreducing of the gold colors, and will not have any harmful effect on the other colors.

Sodium Sulphoxylate Formaldehyde

The second group of the hydrosulphites consists of those compounds that are formed by the reaction of the

hydrosulphite with formaldehyde. Of this group the sodium sulphoxylate formaldehyde is the chief representative. The hydrosulphites combine very easily with formaldehyde to form products that are more stable to heat and at the same time retain their strong reducing powers. The following formula illustrates this reaction:

$$Na_2S_2O_4 + 2CH_2O \rightarrow NaH.SO_2.CH_2O + NaH.SO_3CH_2O$$

You will notice that according to the above equation every molecule of hydrosulphite gives one molecule of sulphoxylate formaldehyde and one molecule of bisulphite formaldehyde. The bisulphite formaldehyde has no strong reducing properties; consequently a product formed by the above reaction has only about one-half the reducing power that a pure sulphoxylate compound would have.

There were several compounds of this nature containing the bisulphite formaldehyde in fairly large proportions, as well as the sulphoxylate formaldehyde on the market previous to the war, but practically all of the products on the market now have only the sulphoxylate formaldehyde with very little if any bisulphite formaldehyde present.

Physical and Chemical Properties.—Sodium sulphoxylate formaldehyde is a white crystaline product, having the formula $NaHSO_2.CH_2O.2H_2O$, and a molecular weight of 154, and is sold in lump, pulverized or liquid form. It is soluble in water, alkalis and dilute acids, and is fairly stable in all of these solutions, although the acid solution must not be very strong and must not be heated for a very long time at too high a temperature, otherwise the free sulphoxylic acid, which is very unstable, will break down. This product melts at about 122 deg. Fahr. It is a very strong reducing agent, but when used by itself does not exert its full reducing action until its solution is heated to approximately 180 to 214 deg. Fahr. It is put on the market at approximately 88 to 92 per cent $NaHSO_2.CH_2O.2H_2O$.

This product has been known under the following trade names: Prewar German names, Hydrosulphite NF Conc., Ronglalite C, Hyraldite C Extra; American names, Sulphoxite C, Hydrosulphite AWC, and Formopon.

Use in Printing Vat Colors.—Sodium sulphoxylate formaldehyde is used very extensively in the printing of vat colors where these colors are made into a paste with caustic soda, hydrosulphite, sodium sulphoxylate formaldehyde and a starch thickener, etc. The cotton piece goods are printed and dried slightly and then steamed. The sulphoxylate compound reduces the vat colors at the steaming temperature and allows these colors to be absorbed by the fabric that is being printed. The material is then oxidized, washed, soaped, etc., to develop the colors.

Use in Dyeing Vat Colors.—Sodium sulphoxylate formaldehyde has recently been found to be of very valuable assistance in the dyeing of vat colors when used in conjunction with caustic soda and hydrosulphite. The usual amount of hydrosulphite is reduced about 40 per cent, and this amount is replaced with the sulphoxylate compound. That vat dyes may be reduced at their regular reducing temperature and dyed at their usual temperature also. On the other hand the vat dyes can be applied at very much higher temperatures, if necessary, in order to obtain better penetration, due to the fact that the Formopon does not tend to break down at the higher temperature as quickly as hydrosulphite. The above formula produces more level dyeings on light, difficult shades than can be produced with a plain hydrosulphite vat, and shows a greater difference in the evenness of the dyeing when the vat colors are applied to rayon material, but there is also sufficient difference obtained in the dyeing of cotton to make it very useful in this connection also. The reason which has been attributed to the improved results by using the combination of sulphoxylate and hydrosulphite, is that there is evidently a chemical reaction between the two compounds in this solution, and also that the sulphoxylate is a more stable reducing agent.

The addition of sodium sulphite to a vat dyeing bath is also of valuable assistance in maintaining a more even reduction throughout the dyeing, which tends to give more level dyeings.

Use in Discharge Printing.—The sulphoxylate compound is also used in discharging colors in the printing industry by mixing the sulphoxylate with a neutral, acid or alkaline thickener, and applying this discharge paste to the dyed fabrics. The fabric is then steamed and the sulphoxylate discharges the direct cotton and acid colors to a white pattern on a colored ground. There are several colors which discharge to a better white in a paste made slightly acid with acetic acid, and on the other hand there are a few colors which discharge better with alkaline discharge paste. When satisfactory results are not obtained with a neutral discharge paste it is advisable to conduct experiments using small amounts of acetic acid to render the paste acid, or soda ash and caustic soda to cause the paste to be alkaline. Great care must be exercised in preparing the acid paste to prevent foaming, which is caused by the liberation of carbon-dioxide when the acid paste comes in contact with the soda ash, which is found in some types of sulphoxylate compounds on the market. The sulphoxylate compound should be almost completely soluble in water, but is not necessarily obliged to have a water clear solution. The presence of soda ash in a sulphoxylate compound may be determined by dissolving 5 to 10 grams in about 100 c.c. of water and adding a small amount of dilute acid. If soda ash is present, the solution will foam and give off carbon-dioxide

gas. This will cause the printing paste to foam, if the paste is slightly acid (as some pastes that are found on the market are slightly acid), or if acid is intentionally added. When a water solution of sulphoxylate is slightly cloudy, it does not indicate that it is not completely soluble, but it shows in a good many cases that there is a colloidal stabilizer present, which forms a very finely divided suspension. This type of stabilizer does not cause foaming and it may be used in acid pastes with very much better results.

Discharging of Vat Colors.—Vat colors may be discharged by preparing a fairly strong caustic sulphoxylate paste containing sufficient sulphoxylate to thoroughly reduce the vat dyed ground, and three to four parts of anthraquinone paste per 100 parts of printing paste (by weight) and 10 to 15 parts known to the trade as Leukotrope W, Leukogene and Indopon W. The vat dyed piece goods are printed with the above thickener and steamed for about five minutes at 214 deg. Fahr., and then passed through a boiling solution of soda ash, washed, scoured, washed and soaped, washed and dried. The operations following the steaming should be made continuous. Not all of the vat colors discharge to a pure white by this formula, but it serves as a very satisfactory method for quite a large number of vat colors, and as a basis of a formula for discharging more difficult colors. I have some samples of various vat colors that were discharged by this method, which can be seen after the meeting if any of the members are interested.

Stripping Vat Colors.—It is occasionally necessary to strip vat colors which have been dyed on raw stock, yarn or piece goods, by the following formula:

> Boil the material out in a 2 per cent caustic soda solution for 5 to 10 minutes, then add 3 to 5 parts of sulphoxylate per 100 parts of liquor and continue to boil until the color is thoroughly reduced. Then add 1 to 2 parts of Indopon W and boil 20 to 30 minutes longer, or until the color is sufficiently stripped. The material is then neutralized, washed and redyed or finished as desired.

There are also a few samples of this work which may be examined after the meeting is over. The above formula can be varied to suit individual requirements, by varying the percentages of the several chemicals used. The Indopon W forms a chemical compound with the reduced vat dyes (leuco bases), which is soluble in an alkaline solution and which will not reoxidize to the original dye. This formula has been known for a very long time for producing a white discharge on Indigo dyed fabrics. An orange discharge may be produced on Indigo dyed fabrics by using Indopon O instead of Indopon W. The Indopon O is dimethyl-phenyl-benzyl-ammonium chloride. You will notice that it is almost the same as the Indopon W. Indopon W is a sulphonation product of Indopon O.

Stripping of Direct Cotton and Acid Colors.—The sodium sulphoxylate formaldehyde compounds can be used in a neutral, alkaline or acid bath for stripping the above colors. Some colors strip better in an acid bath than they do in a neutral or alkaline bath. Therefore, the following formulæ are given to illustrate the different methods that can be used for this purpose:

For use in alkaline bath—

> The goods are boiled in a solution containing 5 per cent of Formopon and 1 to 2 per cent of caustic soda (or 3 to 5 per cent of soda ash) on the weight of the goods, for about 15 to 20 minutes, or until the colors have been stripped. After stripping, the goods should be neutralized in a dilute acid solution to destroy the strong alkali. This will also improve the strip.

For use in neutral bath—

> The full value of the sulphoxylate compound is not obtained when stripping in a neutral bath, although there may be occasions when this is necessary and can be done by boiling the goods with about 5 per cent of sodium sulphoxylate formaldehyde (on weight of goods).

For use in acid bath—

> The goods are heated to a boil in a bath containing 5 per cent of sulphoxylate compound and 3 per cent of acetic acid (28 per cent). The bath is held just below a boil for 20 to 30 minutes and then drained and washed thoroughly.

Basic Zinc Sulphoxylate Formaldehyde

Physical and Chemical Properties.—Basic zinc sulphoxylate formaldehyde is a grayish white powder having the chemical formula $ZN<\begin{matrix}OH\\HSO_2.CH_2O\end{matrix}$ and the molecular weight of 177. It is insoluble in water but soluble in alkaline and dilute acid solutions. It is very much more stable in acid solutions than the other sulphoxylate compounds, and may be boiled vigorously in a weak acid solution without breaking down. It is never used in an alkaline solution but is a very strong reducing agent when used in an acid bath, although it does not exert its full reducing powers under 180 to 212 deg. Fahr. It is a very stable product and keeps almost indefinitely when kept dry. It is put on the market at approximately 90 per cent Zn (OH).(HSO_2).(CH_2O). This product has been known by the following trade names: Prewar

names, Decroline, Hyraldite Z; American names, Hydrosulphite, Formopon Extra.

Use in Stripping.—These compounds are used almost entirely for stripping woolen shoddy in an acid bath. The material to be stripped should be scoured with some mild alkali such as 3 to 5 per cent of ammonia or 1 to 3 per cent of soda ash to remove as much dirt, grease and loose color as possible before using the more expensive stripping agents. After the alkaline scour the loose color is washed off and a fresh bath containing 5 to 10 per cent of acetic acid (28 per cent) or 1 to 2½ per cent sulphuric acid or 3 to 5 per cent sodium bisulphate is heated to a boil, and then 3 to 6 per cent of Formopon Extra (on weight of goods) is added and the boiling continued from 30 to 40 minutes. The material is then drained thoroughly and washed. If too much sulphuric acid is added to the bath or if the bath is boiled too long, it will tend to break down into free sulphur, and the bath will become cloudy, which indicates that its stripping strength has been practically consumed. When stripping material that has been carbonized and not neutralized, it is necessary to use a correspondingly larger amount of alkali in the preliminary scour to neutralize the carbonizing acid and still have enough alkali left to loosen the grease, dirt and loose colors on the woolen fiber. Formopon Extra may be used for stripping other fibers, but it is best suited for woolen material, and the other compounds mentioned in this paper are better suited for stripping such fibers as cotton, silk, rayon, etc.

Normal Zinc Sulphoxylate Formaldehyde

Physical and Chemical Properties.—Normal zinc sulphoxylate formaldehyde is a white crystaline powder having the chemical formula $Zn<\begin{matrix}HSO_2.CH_2O\\HSO_2.CH_2O\end{matrix}$ and a molecular weight of 255. It is soluble in water and dilute acids, and is stable in these solutions if they are not boiled too long. It is insoluble in alkaline solutions, due to the fact that it goes back to the basic zinc sulphoxylate formaldehyde. It is a very strong reducing agent in an acid bath, and is about one-third stronger than the basic salt, due to the fact that there is an extra sulphoxylate formaldehyde radical which replaces the hydroxyl (OH) radical. This product has been known under the following trade names: Prewar German name, Soluble Decroline; American names, Protolin and Hydrosulphite.

Use in Stripping.—This product is probably the strongest stripping agent for certain dyes which are found on woolen and silk material, and also for a few cotton and acid dyes which are used in the hosiery trade. Protolin is always used in a weak acid bath and at 180 to 210 deg. Fahr. The material to be stripped is generally prepared by scouring with mild alkalis, such as was described under "Stripping with Basic Zinc Sulphoxylate Formaldehyde." The material is then washed and the stripping bath containing 5 to 7 per cent of acetic acid (28 per cent) or 1 to 2 per cent of sulphuric acid or 3 to 4 per cent of sodium bisulphate is heated to a boil and 2 to 4 per cent of Protolin is added to the boiling bath without dissolving. Boiling is continued for 20 to 40 minutes, then the bath is drained thoroughly and the material washed.

Use in Discharge Printing.—Although Protolin does not have a very extensive use in this class of work, still its properties of being a stable reducing agent in an acid paste makes it a valuable product for occasional use where it is necessary to use a fairly strong acid discharge paste. The Protolin will exert its reducing power at the steaming temperature in the same manner as the normal sodium sulphoxylate formaldehyde, and due to the fact that the discharge paste is distinctly acid, a whiter discharge will be obtained on certain ground colors which do not give a clear white when neutral, alkaline or mild acid discharge pastes the used.

Special Stripping Compounds

There have been several special stripping compounds and discharging agents brought on the market for various special uses, but they are not all strictly pure compounds and are generally mixtures of the above-mentioned compounds with some catalytic agents, such as anthraquinone, etc., to aid in the discharging and stripping properties of the various compounds. Or they are mixtures containing acid salt, which renders it unnecessary to add the full amount of acid when stripping or discharging.

The Manufacture of Sulphur Dyestuffs*

By John L. Crist

Manager, Beaver Chemical Corporation, Damascus, Va.

In this paper it has been decided to refrain from a purely technical discussion and to treat the subject of the manufacture of sulphur dyes in a general and rather practical manner. Sulphur dyes have been generally regarded and for the purpose of this paper will be considered as those dyes which are applied to the fiber by the aid of the alkaline sulphides, the most common, and, in fact, the sulphide of universal use being the well-known sodium sulphide of commerce.

The means of manufacturing sulphur dyes were discovered late in the 90's, and this class of dyes first found general and favorable use from 1900 to 1910, after over-

*A paper read before the joint meeting of the South Central and Piedmont Sections of the American Association of Textile Chemists and Colorists at Asheville, N. C., July 16.

coming much prejudice which many present will easily recall.

For the sake of clarity the manufacture of sulphur dyes has been divided into two main subdivisions. First, that class of sulphur dyes that are manufactured by the baking, roasting or so-called dry fusion process. A few examples of this class are Sulphur Browns, Sulphur Tans and Crutches and Sulphur Yellows of the redder shades. And second, that class manufactured by the so-called wet fusion process, a few typical examples of which are Sulphur Blacks, Sulphur Navy, Sky, and Brilliant Blues, Sulphur Bordeaux and Sulphur Green. In general, subject to certain exceptions, the cheaper and duller dyes are made by the dry fusion process, some of which, however, have exceptional fastness and good working qualities, and the brighter more expensive shades are produced by the wet or aqueous fusion process.

One typical shade or type has been selected from each of these general classes for rather detailed study. From the dry process class Sulphur Yellow of the soluble reddish type largely used in combination for producing khaki shades has been selected, and from the wet fusion class the well-known Sulphur Navy Blue has been selected as typical.

How Sulphur Yellow Is Made

An outline of the process for manufacturing Sulphur Yellow of the reddish type is as follows:

Certain definite amounts of sulphur, meta-toluene-dyamine or the formyl, diformyl and aldelyde derivatives of meta-toluene-dyamine and benzidine are heated in an iron pot, kettle or mixer to about 300 deg. Cent. or 575 deg. Fahr. for a period of time about 12 to 30 hours. During this process hydrogen sulphide is evolved and towards end of the reaction the mass becomes quite thick. At this point in the process the semi-fluid mass is sometimes transferred to pans, and the process carried to completion by continued heating at higher temperatures in a so-called baking oven, constructed in general along the lines of a baking oven in an ordinary kitchen range or a commercial bakery. The baking process is usually carried on with the exclusion of air to prevent combustion of the dyestuff, until the mass becomes quite stiff. When the reaction is considered complete the furnace is allowed to cool, whereupon the mass becomes quite hard and brittle.

Formerly quite a number of tans and browns were taken at this point and merely ground to the desired fineness, blended with salt for standardization and marketed in the crude state. Even now some of the cheaper dark browns and tans are found on the market prepared in this way. However, the best practice to insure a uniform product with the minimum of insoluble matter is to dissolve this mass in a solution of sodium sulphide or caustic soda, filter the solution and precipitate the refined dyestuff from the solution by the use of an acid and acid salt or by blowing air through the dilute solution to oxidize the sulphide. The liquor containing the dyestuff in suspension is then filtered, the precipitated dyestuff dyed, ground, blended with salt, sodium sulphate, etc., to standardize, and marketed.

We will now take up in a general way the manufacture of Sulphur Navy Blue as representative of the wet fusion process class.

The first step in this process is the preparation of para-nitroso phenol, which is formed by the action of sodium nitrite on phenol (carbolic acid) in an acid solution at a temperature of near 0 deg. Cent. This para-nitroso phenol is filtered, wrung in an extractor, analyzed and stored in a cool place. It is quite combustible and inflammable, and great care must be used in handling and storing it.

The second step is the preparation of the color base or the indo-phenol by the condensation at low temperatures in a solution of sulphuric acid of the para nitroso phenol and ortho-toluidine. When this extremely delicate reaction is complete the mass is run into a dilute solution of soda ash and the acid neutralized with the resultant precipitation of the indo-phenol which is filtered and analyzed but not dyed, as the color base is quite unstable and must be used fresh.

The third step is the preparation of a sodium polysulphide by heating together certain quantities of sodium sulphide in solution and sulphur. The indo-phenol is then dissolved in the sodium polysulphide, the solution brought to a definite boiling point by evaporation or dilution and run at boiling in a closed tank or kettle equipped with a reflux condenser for a certain period from 12 to 100 hours until reaction is completed. During the fusion cycle there is quite an evolution of hydrogen sulphide. The strength of the polysulphide, the proportion of sulphur to the sulphide, the temperature and the time of the fusion reaction are all varied to produce the desired shades. Also certain solvents and fusion assistants are sometimes employed to produce certain shade or solubility results. Among these assistants are alcohol, glycerine and their derivatives.

The fourth step consists of diluting the completed fusion and precipitating the dyestuff from the sulphide solution by means of acid, acid salts, or by blowing air through the solution to oxidize the sulphide.

The fifth step consists of filtering the precipitated dyestuff drying, grinding, aging and standardizing by blending various batches and reducing with salt, sodium sulphate, etc., and marketing.

It is quite essential in almost all classes of sulphur dyes to give them an aging process after the finished dyestuff

is dried. This is to permit the dyestuff to take up from the atmosphere its desired amount of moisture and oxygen and to become stable in this respect; otherwise the change goes on after standardization, resulting in "off standard" dye, and in some cases when the barrel is opened and the dyestuff permitted to come in contact with the air a rapid oxidation takes place with resulting firing of the dyestuff in the barrel.

The kind of water used in the various manufacturing processes also exerts a powerful influence on the shade and solubility of the dye. In general, the purer the water the more soluble and brighter the dye. Soluble metallic salts in the water exert a very harmful influence.

Lead, iron and wood are the principal materials of which the apparatus is constructed. Iron is nearly always preferable owing to its low cost and permanency where its use is permitted. Some dyes are very sensitive to iron, in which cases it is necessary to resort to other metals. Certain sulphur dyes that are sensitive to iron can be produced in lead apparatus, and when dyed in glass or porcelain dye pots in the laboratory give brighter shades. However, when dyed in iron machines the shade is materially affected so that most of the apparent advantage of the lead apparatus is lost. Others are not so sensitive to iron in dyeing and lead or lead lined apparatus is quite desirable. Copper or brass must be avoided around the sulphide fusion kettles, as the copper is readily attached by the sulphide. Also wrought iron and steel are more resistant to sulphide than cast iron.

The most desirable location for a factory to make high grade sulphur dyes is:

1. Where an abundance of pure water is available.
2. Where sewage disposal can be readily affected and where obnoxious fumes are not prohibited.
3. Where high grade intelligent labor is available.
4. Where the source of raw materials is near and where the market for the product is sufficiently close to avoid too much delay in shipping the product. The amount of raw materials used exclusive of fuel is often 8 to 10 times the weight of the finished dyestuff. Therefore, the proximity of the factory to the source of supply of the chemicals is more important from the standpoint of transportation than to be close to the consumer. However, the question of service to the consumer must have serious consideration.
5. Where power or fuel or both are cheap.
6. Where the climate is not too rigorous to prohibit the use of lightly constructed buildings, as light and ventilation are prime essentials.

Need of Accurate Control

We have covered a general outline of two typical processes of the two general classes of sulphur dyestuffs, also some generally related factors. Now from the time the process for the first intermediate is begun until the dyestuff is in the barrels in a dry warehouse the factors of proportions of the various chemical ingredients, the factors of time, temperature, concentration, agitation and other plant conditions must be controlled within very narrow and predetermined limits. All these factors have a direct bearing on the properties of the dyestuff, such as shade, strength, solubility, uniformity, fastness, property of changing much or little on oxidizing and aftertreating, and, in fact, practically all the properties of the dyestuff are subject to and controllable by the various factors above mentioned. During all these processes accurate laboratory control must be maintained as a check on and a guide to the plant procedure. This includes analyses of raw materials and intermediates and a constant checking of finished batches regarding all their properties.

Of all the classes of dyestuffs, the sulphur dyes, because they are in most cases not definite chemical individuals but mixtures of many, are most susceptible to plant factors and conditions, and consequently they require the greatest amount of care in their preparation. It might be said that the single greatest factor contributing to the manufacture of a high-grade sulphur dye is *eternal vigilance* all the way down the line.

It is difficult to pass from the discussion of manufacturing without touching on the testing of the dyestuff in the laboratory of the producer, and likewise in the laboratory of the dealer or sales agent and the consumer. Almost all sulphur dyestuffs are undetermined and undeterminable mixtures of various related chemical individuals, and very few are definite chemicals themselves. Also the properties of fastness and solubility, properties of being reduced and oxidized, properties in respect to aftertreating and exhaustibility are all strictly *relative* properties. Therefore, with so many variables it is essential that the producer, the agent and the consumer all follow the same testing procedure to the *minutest detail* if comparable results are to be expected. The producer should know the use to which his product is to be put, and all parties concerned should adjust their dyeing and testing procedure to the closest approximation of the consumers' conditions as is possible to do so.

It is of great assistance to the manufacturer and also of great mutual benefit to the consumer when the manufacturer can know to what use his product is to be put by the consumer. Only in this way can the best results be secured by both, for the manufacturer, knowing certain mill conditions, can often change his processes so as to give to a certain color certain qualities that are especially desirable under given mill conditions, whereas, had he not known these peculiar conditions, his product, while suitable for most conditions, might be unsuited to

this particular condition. In this event neither the manufacturer nor his product nor the consumer nor his conditions are to be wholly blamed; ignorance and unwillingness to co-operate are the causes of most troubles along this line.

The manufacturers observe with unmixed gratification the constantly improved personnel in the dyehouses, and he looks forward to the time when all dyehouse superintendents will be technical experts trained in the application of dyes and related subjects.

May we all—manufacturers, dealers, agents, dyers and consumers—work and pray to the end that the time will soon come (and let us do our part to hasten it) when there will exist a complete spirit of co-operation and helpfulness between consumer and manufacturer, and a mutual willingness and desire to go to the bottom of our mutual troubles before blaming some product or condition, when in most cases our troubles can be eliminated or minimized by intelligent co-operation.

FORTY-SIXTH COUNCIL MEETING

The Forty-sixth Council Meeting of the American Association of Textile Chemists and Colorists was held at the Engineer's Club, Boston, Mass., June 17, 1927.

The following members were in attendance: L. A. Olney, E. H. Killheffer, W. C. Durfee, G. A. Moran, P. F. Ripley, H. Christison, H. W. Leitch, W. M. Stott, Wm. H. Cady, Wm. D. Appel, W. E. Hadley.

Letters of regret at being unable to attend the meeting were received from P. J. Wood, W. S. Williams, Ed F. L. Lotte, W. R. Moorhouse, R. F. Culver, R. W. Hook.

The following applicants were admitted to membership:

Active Members

Benson, Cyrus M., proprietor, E. & R. Cleaning & Dyeing Company. Address: Smart Street, Cambridge, Mass.

Crist, John L., manufacturer of dyestuffs. Address: Damascus, Va.

Emerson, Robert M., silk dyer, Cooper Kenworthy Company. Address: Warren, R. I.

Harkness, Arthur F., chemist, Lewis Manufacturing Company. Address: 1122 Main Street, Walpole, Mass.

Herstein, Karl M., consulting chemist. Address: 227 Front Street, New York, N. Y.

Herzog, George Ernest, assistant dyer, Wood Worsted Mills. Address: 14 Chestnut Street, Lawrence, Mass.

Levering, John A., wool scourer, Eavenson & Levering Company. Address: Camden, N. J.

Wheatley, Arthur, foreman dyer, Finco Dye & Print Works, Inc., Brooklyn, N. Y. Address: 7832 89th Avenue, Woodhaven, L. I., N. Y.

Woodhead, H. A., vice-president and superintendent of Gregg Dyeing Company. Address: Graniteville, S. C.

Junior Members

Dick, Carroll, C., student, Philadelphia Textile School, Philadelphia, Pa. Address: 160 W. Windsor Street, Reading, Pa.

Haack, Edward C., student, Philadelphia Textile School, Philadelphia, Pa. Address: 512 Magee Street, Philadelphia, Pa.

The following members were transferred from Junior to Active Membership: Lester H. Bailey, Pasquale P. DeNuccio, Albert H. Blades, Roland Kittredge, John C. Zwaan, Mark L. Davis.

Professor Olney, on vote of the Council, appointed the following committee to consider revision of the Constitution in order that the Council may have more definite instructions which may be followed in considering applicants for membership. The committee consists of Wm. H. Cady, E. H. Killheffer, Wm. R. Moorhouse and H. Christison.

William C. Smith has been appointed to the position of Association Research Chemist, and will be located in Washington, D. C., under the direction of W. D. Appel for the present.

Considerable time was devoted to the data which is to appear in the coming Year Book. Each committee chairman was requested to carefully consider the work which is to appear in the Year Book and to render a report of any revisions, in writing, to the president in order that they could be incorporated in the Year Book.

Amendment

The following amendment to Article VIII of the Constitution was duly passed, same having been presented at the annual meeting in Charlotte, N. C., last December, after which it was passed to letter ballot.

306 ballots were in favor of the change.
1 ballot not in favor.
1 ballot blank.

The amendment reads as follows:

Third Paragraph, omit the words "Excepting the first election" to "at least ten nominating ballots" and substitute the following:

> Not later than July 1st in each year each Section shall elect one of its members to serve on a committee to prepare nominations for the annual election. The local secretaries shall send the names of their respective committee members to the Secretary of the Association, who shall serve as Chairman of the Committee without vote. The Committee shall publish in the "Proceedings" of the Association between

October 1st and October 15th, at least one nomination for each office and at least two nominations for Councillor. Counter nominations for any office, signed by at least ten members, may be filed with the Secretary not later than November 1st.

The Secretary shall then prepare and issue an official ballot containing the names of all nominees.

In accordance with Amendment to Article VII of the Constitution the following members have been appointed to serve as members of the nominating committee for the election of officers for the coming year:

New York Section—P. J. Wood.
Northern New England Section—W. H. Cady.
Rhode Island Section—R. F. Culver.
Philadelphia Section—S. C. Bertolet.
Piedmont Section—R. W. Arrington.
South-Central Section—Tom Taylor.

Respectfully submitted,

W. E. HADLEY, *Secretary.*

Applicants for Membership

Active Members

Blair, William F., dyer, Franklin Process Company, Providence, R. I. Sponsors: A. N. Dana and W. A. Trayer.

Braun, Carl, boss dyer, Phoenix Dye Works, Chicago, Ill. Sponsors: H. D. Arnold and Ed Weber.

Crayton, W. F., demonstrator, E. I. du Pont de Nemours Company, Charlotte, N. C. Sponsors: E. P. Davidson and D. C. Newman.

Griffin, Frank A., salesman demonstrator, American Cyanamid Company, New York, N. Y. Sponsors: W. S. Williams and P. Lavoie.

Griffith, Ivor, director of laboratory, J. B. Stetson Company, Philadelphia, Pa. Sponsors: C. H. Mullin and E. C. Bertolet.

Howerton, R. D., dyestuff demonstrator, National Aniline & Chemical Company, Charlotte, N. C. Sponsors: H. A. Rodgers and A. R. Akerstrom.

LaPiana, Fred G., chemist, Charlotte, N. C. Sponsors: D. S. Moss and C. H. Stone.

Reeder, J. P., assistant dyer, W. B. Davis & Son, Fort Payne, Ala. Sponsors: G. H. DuBois and H. A. Rodgers.

Robertson, I. D., assistant chemist, West Shoals Bleachery, S. C. Sponsors: C. H. Stone and D. S. Moss.

Schneider, Bernard, boss dyer, Lyons Piece Dye Works, Paterson, N. J. Sponsors: A. Maurer and Otto F. Graenicher.

Scott, Gordon M., chemist, Holden Leonard Company, Bennington, Vt. Sponsors: Chas. F. Schaumann and George O. Linberg.

Takamine, Jr., J., president and director of research, Takamine Laboratory, Clifton, N. J. Sponsors: E. H. Killheffer and C. F. Schaumann.

Lumley, Arthur C., representative in Japan, National Aniline & Chemical Company, Kobe, Japan. Sponsors: William R. Moorhouse and W. M. Scott.

Taylor, Charles W., cotton dyer, Houghton Company, East Hampton, Mass. Sponsors: S. Clark Lilley and Charles H. Stott.

Junior Members

Davies, Earl E., chemist, National Aniline & Chemical Company, Chicago, Ill. Sponsors: R. P. Cole and Fred E. Beecher.

Peacock, Benjamin B., student, Georgia School of Technology, Atlanta, Ga. Sponsors: C. A. Jones and P. F. O'Neill.

Salomon, Henry E., colorist, Strongs Piece Dyeing & Finishing Company, Paterson, N. J. Sponsors: Charles Spurr and Ed J. Porthier.

Changes of Address

Barlow, Nelson, Slater Company, Inc., Webster, Mass.

Borrmann, Bernhard, 435 South Church Street Charlotte N. C.

Brosnan, Wm. F., Price Fire & Waterproofing Company, Poughkeepsie, N. Y.

Chase, Harold D., 5110 Walton Avenue, West Philadelphia, Pa.

Clapham, H., chemist and superintendent of dyeing, Hockamin Mills Company, Rockville, Conn.

Conley, L. F., 1 West Silver Street, Middletown, Conn.

Fleming, Jr., J. T., Union Bleachery, Greenville, S. C.

Joerger, Robert, assistant chemist, Merrimac Manufacturing Company, Lowell, Mass.

Laycock, Joseph G., 28 Blossom Street, Lowell, Mass.

Marsh, Robert E., 97 N. Merrimac Street, Manchester, N. H.

Mason, Frederick, Bodell Building, Custom House, Providence, R. I.

Mazer, Samuel, the Wilber Skein Dyeing Company, 1611 River Street, Hyde Park, Mass.

Merriam, Paul A., care of the U. S. Finishing Company, 389 Charles Street, Providence, R. I.

Metz, William G., 37 Clinton Street, Newark, N. J.

Smith, William C., 4107 Connecticut Avenue, Washington, D. C.

Sutcliffe, George W., 204 Lenox Avenue, Providence, R. I.

Thompson, Edw. F., Webster, Mass.

Warshaw, Floyd F., 720 West End Avenue, New York, N. Y.

AMERICAN DYESTUFF REPORTER

Devoted to the use and application of dyestuffs and the mechanical equipment incidental thereto.

LOUIS A. OLNEY
PROFESSOR OF CHEMISTRY AND DYEING, LOWELL TEXTILE SCHOOL
Directing Editor

CLAYTON HOAGLAND
Managing Editor

MYRON DREW REESER
Advertising Manager

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THE OTHER FELLOW'S PROBLEMS

THAT brilliant American philosopher, Henry David Thoreau, once wrote: "Could a greater miracle take place than for us to look through each other's eyes for an instant?" How much there is in that thought! What one of us would not be enlightened by occasionally looking at things from another mortal's view? This principle underlies most of that co-operation about which we hear so much to-day in business. Surely, one man cannot very well help another until both reach some common understanding, so they may see how some of their problems can be solved together.

Too many men in business, however, ignore this truth. They ignore it whenever they are unwilling to work with one another where such co-operation will help both of them. Take the dyer, in his relation to the dye manufacturer: too often does he turn away from the other's offers to assist him. In his article on the "Manufacture of Sulphur Dyes," in this issue, John L. Crist shows clearly some of the benefits enjoyed by dyer and dyestuff man alike when they learn to understand each other's problems. "Ignorance and unwillingness to co-operate are the cause of most troubles along this line," he declares. True enough! A mill orders a keg of color; the order is filled and paid for, the color delivered, and there the transaction ends. But presently the dyestuff man receives a cogently worded complaint: the shade was off, or the strength, or the color acted queerly in the bath. Henceforth, the mill advises, it will have no more to do with his products. No thought is taken that perhaps the dyestuff maker not only may be able to remedy the trouble but is always ready to try if the mill will only accept his co-operation.

Until a mill man realizes how the dyestuff manufacturer is able to help him, however, there can be little advancement of their common interests. If the dyer could look for an instant through the eyes of the man who makes his colors he would appreciate the complexity of the process of making dyes. To him would come the understanding that leads to mutual interest, as he learned that the properties of a dye may be controlled during its manufacture to make the color fit some special need. It would at once be clear to the dyer that it is to his interest to tell the manufacturer how he intends to use his colors. There is nothing artificial about such co-operation. It is consistent with both commercial relations and scientific practice.

THE READER BE——SERVED

IMMEDIATELY following there is published, under the caption "What Shall We Say or Write?", a communication from a constant reader of the REPORTER. He offers a few suggestions on the subject of what a technical journal of this kind should contain. He advances the idea that more articles should be contributed by readers who know some special phase of textile technology well enough to write about it. It may be mentioned that he puts into practice what he preaches by occasionally sending us an article for publication.

Inasmuch as he refers to the REPORTER, a statement of the editorial policy of this journal should be rather pertinent at this time.

While it is truly stated by our correspondent that the fundamental problem of the editorial staff is to fill each issue with readable text, this, assuredly, is not the most difficult editorial problem. To provide, issue after issue, from one year's end to another, a varied, well-balanced and carefully prepared mass of material which, in part at least, will hold the interest of every subscriber and reader—that, to put it modestly, is the problem most acutely felt by the editorial department of a paper. The more specialized a journal aims to be, the more difficult it is to achieve a pleasing variety in its contents.

Furuthermore, as the circulation of a paper increases it becomes concurrently harder to maintain that unmarred satisfaction for which every editor strives. In the case of the AMERICAN DYESTUFF REPORTER it is conservatively estimated that there are at least twenty-five hundred regular readers and undoubtedly a greater number who occasionally, in schools and libraries, skim over its contents or read some special articles that have been brought to their attention.

A survey of the character of these readers would result in their classification into five groups, which may best be typified as follows:

1. The highly educated, technically trained textile colorist.

2. The experienced dyer, printer, bleacher and finisher who may have little if any technical or chemical training.

3. The textile chemist who may possess a thorough

knowledge of the chemical and technical side of dye application and finishing but who has had no extensive practical experience.

4. The man whose chief interest is the manufacture and distribution of dyes.

5. The student or apprentice who, having decided to enter the field, faces what to him is an unexplored realm so far as search for knowledge is concerned.

Obviously it would be impossible to fill every issue of a publication, or even one number, with material that would be of equal interest to all of these groups. Articles of absorbing interest and value to the first group would most likely be far too advanced to attract members of the last, while material of greatest value to the latter would probably not interest the first group any more than a child's set of blocks would interest a construction engineer. In short, no journal ever attempts to satisfy all of the readers all of the time. But we feel that unless we can interest all of the readers some of the time we are falling short of our objectives and ignoring our ideals. The editorial staff's chief problem, therefore, resolves itself into the task of selecting all material with one principle in mind, namely: that the needs of every reader should be satisfied as often as possible.

It is our belief, therefore, that in a reasonably small number of consecutive issues one or more articles should appear that would be of interest to each of the five groups enumerated. There should be included a limited number of articles of an advanced technical nature, a somewhat larger number dealing with the practice and theory of dye application, bleaching, finishing, laundering and dry cleaning, and a sufficient number of well-written articles involving nothing new but which will furnish instruction pages for members of Group 5 and serve as an easy means of review so often sought by some of the other groups.

In addition to these original papers, space should be devoted to articles translated or reprinted from other journals. In our opinion, the publication of high-grade articles from journals not available to the majority of readers may prove of greater value than original articles of less merit.

News items of general interest to the industry, reviews of its literature, abstracts of articles appearing in other journals and of patent literature, and editorial comment should be given such space as may be required to round out the contents and add to the usefulness of the publication. Furthermore, a journal should make every effort to serve subscribers as a kind of co-operative clearing house for all material coming within its specialized field.

We appreciate the interest of our correspondent and request that others express their opinions and suggest other ways and means by which our readers as a whole may be better served. For what does it profit a publication if it be formed only to suit the ideas of its editors?

What Shall We Say and Write?—I

A Communication from a Reader

MOST of us have too much to read already. But many of us complain because so much of this material is not of the highest quality, and reading it in search of the few real facts is so often a waste of time. This short contribution is to suggest, from a reader's point of view, some of the things that should find a place in a publication that is intended to be an authority in its field, and it is meant to emphasize quality rather than a greater quantity.

Any technical editor's first problem is to fill the space in every issue. The second is to have the quality as high as possible. This may be a rather blunt way of putting it, but there are undoubtedly instances when certain material would not be printed if better were available, and that is all that is necessary to carry the point.

By way of improving matters, there are many readers of the REPORTER who could contribute interesting and informative articles on the science or technology of textiles if the spirit would but move. The bashful would not even have to sign their papers, but articles signed by the specialists who write them are always more respected.

There is still a peculiar tradition of secrecy pervading the whole field of textile manufacture. No doubt it is a natural tendency for each of us to think that he is just a little smarter than the other fellow, and it is therefore natural for manufacturers to think that they are just a little ahead and to wish to stay there. This has militated against publicity, although there has always been plenty of "confidential" swapping of information. Probably the importance of style has also had quite a bit to do with the cultivation of this habit of reticence, for new styles and methods of producing them must be kept under cover until ready for market if they are to greatly benefit the originator. With some exceptions, however, secrecy is mostly bunk, but unfortunately there must still be due respect for those who consider it important.

This paragraph or two of preamble, it is now assumed, has led up to the statement that there is a field for good general articles on how things are done in all textile lines, even though such articles may not contain all the process details. Readers often seem to expect that articles written by others on mill processes on which they themselves are engaged should tell them many things that they do not already know. However, writer and reader are both in the same boat, and if their positions were reversed the result would be about the same: a general article in which the other fellow would find very little that was new to him. As already contended, this is for the good reason that employees are rarely privileged to disclose operating details, even though it might be perfectly harmless to the employer's interests.

Nevertheless, there are many of us who are interested in how things are done in other lines than our own, and since the general principle is often of more importance than the details, such general articles have a definite

value. Most textbooks on the technology of any industrial field are behind practice, yet they are very useful. Similarly the technical journal, even though it cannot satisfy the most technical of its readers, should be as up to date as permitted and can be an authority, or as good an authority, as it is possible to have.

General articles on the properties of materials or on a branch of work are often very valuable and interesting, and perform a real service in presenting from experience or by compilation, matter that is new or not well known. On the other hand, such articles may be only a rehash from books that everybody has, and then, of course, offer an opportunity for the editor to use his discretion. Discussions or critical literature reviews that are not too detailed are often very valuable, not only to read, but to have at hand in one's files; and especially so when they can be presented by someone who has not merely looked up the facts, but really studied his subject. And certainly a literature review is not very confidential.

It is also legitimate to present an article now and then on new dyes, machinery, apparatus, chemicals or proprietary products where there is some new principle involved or, in fact, any outstanding feature. They should have news of real technical value and not be ordinary write-ups of a mere advertising nature.

Not the least important are good practical articles on organization of plants or departments, on administrative subjects or on the more general features of mechanical and electrical equipment. Chemists in their laboratories and foremen in their own departments are all too prone to work for their department rather than for the mill as a whole. Yet a broad view, not only of the manufacturing, but of the selling and final uses of the product, is essential to the most intelligent work and the fitting of each unit into the most successful whole.

So, with an emphatic, "This means You," as a final exhortation, just think of it seriously for a moment, and see if *you* cannot contribute an article, perhaps the kind that you yourself prefer to read.

H. GARDNER McKERROW

Members of the textile and dyestuffs industries lost one of their best known and most faithful associates in the passing of H. Gardner McKerrow, who died on July 16, in his sixty-second year, after an apoplectic stroke.

Mr. McKerrow was a widely known personality in the American dyestuff and chemical industry, and during his long career was associated with many of the important activities that mark the development of that industry. He was connected with Marden, Orth & Hastings, manufacturers of chemicals and dyes, during the war, and later with the National Aniline & Chemical Company as advertising manager. After he left the latter company he was associated for a time with the Althouse Chemical Company, of Reading, Pa. He was prominently identified with the organization of the Synthetic Organic Chemical Manufacturers' Association, and was also active in planning some of the early chemical expositions. During the past few years he contributed numerous articles to business journals on economic conditions in the textile and dye industries.

Mr. McKerrow was born in Lancaster, England, and came to this country about forty years ago. He was at that time a designer of textile machinery, and found employment in Holyoke, Mass. Subsequently he represented in New England the English manufacturers of textile machinery, Tweedales & Smalley. He is survived by a married daughter and a son.

The REPORTER desires to express at this time its sincere regrets at the passing of one who was among its earliest acquaintances in the dyestuff industry and who became, not alone a valued contributor to its pages, but a highly regarded business friend.

A. W. BUTTERWORTH NOW PRESIDENT OF BUTTERWORTH & SONS

After twenty-one years as president and active head of the H. W. Butterworth & Sons Company, Harry W. Butterworth, Sr., great-grandson of the founder of the textile finishing business which has borne the name Butterworth for 120 years, was elected chairman of the board of directors, a newly created office.

The election of the former president of the company to the chairmanship of the board was followed by the election of A. W. Butterworth, former vice-president, to the presidency of the company. He also was made treasurer. J. Ebert Butterworth, formerly treasurer of the company, was elected vice-president in charge of the Southern office, located at Charlotte, N. C. Harry W. Butterworth, Jr., was also elected a vice-president; he formerly was secretary. De Haven Butterworth, who had been assistant secretary, was made secretary, and James W. Butterworth, 2nd, continued as assistant treasurer. The only other office remaining unchanged was that of vice-president in charge of the New England office. A. C. Freeman was elected to this office several years ago and has held it since.

ON USES OF SILICATE

The Philadelphia Quartz Company issues an interesting monthly bulletin entitled "Silicate P's and Q's," containing a variety of information for users of silicate of soda. It is mentioned in the current number, for instance, that tags coated with silicate of soda are being sold to dry cleaners because the silicate is quite soluble in the hydrocarbon solvent used for extracting soup from silk dresses. The silicate readily performs a service, says the item, which would be quite beyond its reach if the liquid were a watery one.

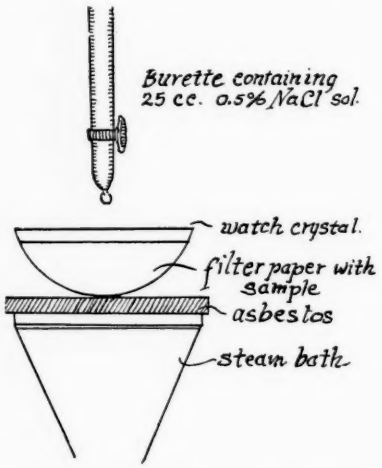
Action of Perspiration on Textiles

By Frances Hall Damon

THE question of perspiration and its effect on textiles being one of the perplexing problems holding the attention not only of the dyer and manufacturer of yard goods, but also of the makers of women's and men's wear, the results of a laboratory investigation in which some solution of the problem was sought might prove useful. It is because of this fact that I submit the following report of my work carried out at the Sterling Chemical Laboratory, Yale University, under the sympathetic direction of Professor Treat B. Johnson, head of the Organic Chemistry Department. My problem was to discover, if possible, the chemical properties of perspiration which produced a change upon the fibers or in the color of yard goods used in making garments.

After reading all available material written upon the subject of perspiration, I felt ready to start upon my laboratory tests. First I tried treating fibers of all the textile materials with single components of perspiration in the concentration indicated by the literature on the subject as the average. As the result of these tests, which took many months before any real results were obtained, common salt was found to be the most destructive ingredient of perspiration.

Working on this result, I used a solution of sodium chloride to make my test for the fastness of color and



decay of fabrics to the action of perspiration. After a long trial to determine an experiment which would carry out as nearly as possible the conditions which in use cause damage to garments, I finally evolved the following test, which I believe will prove useful to those interested in this question. The test follows:

Testing Action of Perspiration

Take 15 cm. filter paper and mount samples (1 cm. x 4 cm.) radially with the inside end 3 cm. from the center of the filter paper. I found that sewing the samples to the filter paper proved satisfactory. Place the filter paper with samples upon an 18 to 22 cm. watch glass and wet with distilled water, pouring off excess water. Place watch glass and contents over a steam bath having a 1 cm. thick sheet of asbestos upon it (see diagram). From a burette allow 25 c.c. of 0.5 per cent NaCl to drop onto the center of the filter paper at a rate to insure that the samples shall always be kept moist but never wet. Allow the filter paper and samples to dry before removing from the steam bath. If there has been bleeding of color on to the filter paper the color is not fast to perspiration. To determine the tendering of these samples they should be examined under the microscope and then their tensile strength obtained. Often the tendering does not take place for some time so that it is sometimes necessary to put away the treated samples for a month or so before performing the tests for tendering.

This test is very different from those in general use now, but is, I feel, just as efficient and much more simple.

WIDE RANGE OF EXHIBITS, ACTIVE WEEK'S PROGRAM FOR CHEMICAL SHOW

Many features have been planned to increase and broaden the interest always manifested in the biennial Exposition of Chemical Industries to be held this year during the last week in September. This year the products of foreign manufacturers have been admitted for display, so that American manufacturers will be given the opportunity of exhibiting and comparing their products with those brought over from abroad.

One of the most interesting and important exhibits will be put on by the National Safety Council. This will contain charts outlining safety work in the chemical industry and special attention will be paid to the nation-wide survey made by the council on the hazards of benzol. The National Safety Council, through its investigations, develop many angles of safety work that benefit chemists, engineers and the industry as a whole.

This year the program of the Students' Course, conducted by Prof. W. T. Read of Texas Technological College, will be divided into two sections. The first will be an elementary course, the second an advanced course. As in the past, rigid tests and records of the student's work will be kept and forwarded to the institution from which the student registers. Dr. Arthur D. Little, H. E. Howe, editor of Industrial and Engineering Chemistry, and Williams Haynes, of Chemical Markets, will speak.

Various sections of the country will exhibit separately, and products such as containers and laboratory supplies will also be classified by sections. Sectional exhibits will be supplemented by displays of chemical products, machinery used in manufacture and processing, dyes and fine chemicals, etc.

The Dorr Company, engineers, have appointed A. Anable to the position of director of publicity. Mr. Anable has been connected for several years with the company's equipment sales department. He assumed his new duties on August 1.

The Silverfish, an Insect Attacking Sized Textile Fibers

Nature of the Insect—Its Ravages on Books and Papers—Damage to Textiles—Method of Protecting Goods from Attack.

By C. O. CLARK, A.T.I.

IN a darkened kitchen a silver insect may sometimes be seen gliding rapidly across the firelit hearth. It is the silverfish (*Lepisma saccharrina* (=*Thysanura sac.*), which, since it loves darkness and seclusion, is seldom noticed, but is much more common than is generally known. Its appearance and habits have earned it a variety of names, silverfish, fishmoth, fish-insect, silverwitch, woodfish, sugarfish, sugar-louse, slicker, and bristle-tail being some of the most common.

It can be a serious pest in connection with textiles, paper, or similar materials, which have been treated with starchy substances. Damage by it, or closely allied species, has occurred all over the world. Though seemingly not so widely distributed as it was, it is still a common inhabitant of dwelling-houses in England. Perhaps the diminished numbers are due to starch not being employed now in households and laundries to the extent that it used to be, and also because resin sizes are now largely used instead of starch sizes in the paper industry.

It was first recorded in 1665 in Hooke's Micrographia as the "Small silver-colored book-worm." He said, "It is a small white silver-shining worm or moth, which I found much conversant among books and papers, and is suppos'd to be that which corrodes and eats holes through the leaves and covers; it appears to the naked eye a small glittering pearl-colored moth, which, upon the removing of books and papers in the summer, is often observ'd very nimbly to scud, and pack away to some lurking cranny, where it may the better protect itself from any appearing dangers." In those days moth, worm, and bug were interchangeable words for any small invertebrate creature, especially if destructive; in fact, in common speech they are still largely used in this manner, particularly overseas.

Description

The silverfish is a very active, flat, fish or carrot shaped creature about one-third inch long, of a shimmering, pearly gray or silver color due to it being completely clad in minute irridescent scales like a fish. The antennæ are very conspicuous, being about two-thirds as long as the body, as is the tail of three long bristles at considerable angles to one another. There are six legs and two conspicuous black compound eyes, but no trace of wings.

Practically nothing is known of its life history. When hatched from the egg it appears to be as fully developed as when mature, and is similar in form, differing only in the proportion of the parts and in depth of color. There is no metamorphs such as occurs with most insects. As it grows it sloughs its skin periodically.

Very closely akin is *Pepisma domestica* (=*Thermobia furnorum*), and the two are often confused. It is ½-inch long and of a pearly white color, hazily mottled with dark spots. Otherwise in its general appearance and habits it greatly resembles *l. saccharrina*. It is abundant in bakehouses, running over hot bricks and metals with impunity, where it might be thought the heat would be enough to kill any insect. This has earned it the name of the baker's brat or fire brat.

My attention was first drawn to these insects by inquiries received as to whether textiles mothproofed with Eulan were also immune to the attacks of silverfish; subsequent work has shown that they are. Considerable differences of opinion were shown in the inquiries as to which fibers were attacked. Search through entomological literature showed similar discrepancies of opinion; for the greater part, modern opinion was that silverfish are essentially farinaceous feeders, though Garman (Bull. 60 Bureau Ent., U. S. Dept. Agric.) states that they do not eat starch, but feed on animal matter such as glue.

Damage to Paper, Books, and the Like

Many cases are recorded of labels being attacked. A typical one occurred in the Geological Museum, Boston, U. S. A., where in the course of a year the surfaces of the cards used to label a collection of stones gradually came to look as though they had been scraped, many of the inscriptions being obliterated. The damage was very gradual, and only done at night, but after much investigation the cause was found to be silverfish, apparently attracted by the starch glazing on the cards; for labels of common writing paper were not attacked.

Damage is often caused in libraries by book backs and leaves being gnawed and scraped in the insect's efforts to get at the sizing beneath, though in other cases the inks used in printing have protected the parts so covered, the pattern in some cases being said to have been neatly picked out.

Butler (Our Household Insects, p. 32) had a case full of transparencies destroyed by silverfish. While little damage was done to the paper, only the thinner parts having been nibbled, the paste that united the different

thicknesses had completely disappeared, and so the papers hung in tatters.

Howard (The Insect Book, p. 382) says they will eat the glaze from drafting linen.

Indian Government records have been seriously damaged, and Butler (*loc. cit.*) records that silverfish have been found in account books kept in a safe in Aldage, London.

They will eat the paste used in papering walls. This has actually happened in the kitchen of my own home in Bradford, where the paper peeled from the wall as a result, and was itself gnawed and shredded in places. At first it was put down to damp, and it was some time before the real cause of the trouble was found to be silverfish. They will gnaw holes in pure unsized paper. Whether they would thrive on such a diet is very doubtful, for clothes moth grubs can similarly be made to gnaw paper, but it is useless to them as nourishment, and they starve to death.

Damage to Textiles by Silverfish

Many instances of this appear in entomological literature. Often it is stated that the materials attacked had been starched, and even where this is not stated it can be inferred from the nature of the articles that this was the case. In the older literature it is frequently stated that starched shirts, collars and cuffs are particularly liable to have their surfaces gnawed and scraped by silverfish. Muslin curtains, dust covers for furniture, table linen, carpets, and garments and tapestries of silk are all said to have been attacked.

Serious trouble was once caused by silverfish in a cotton mill in the Greenfield district, and here the damage was done to sized material.

Wool underfelts filled with starch are sometimes attacked by silverfish in Australia.

Some years ago they swarmed, and became a nuisance in the carpet drying chambers of a Lancashire firm of dry cleaners. Probably they lived on the sizing from the carpet backs and in the felts placed in the chamber, though it was never noticed that any damage was done.

However, it is hardly to be expected that any noticeable amount of damage could be done during the short period any individual carpet or felt was in the chamber. Fumigation with sulphur and many other methods were not successful in getting rid of them; in the end their numbers diminished for no ascertained reason, though they are still fairly plentiful.

During the last three years many trials have been made in various parts of the world by exposing fabrics to the attacks of silverfish, and as a result it can be definitely stated that neither pure wool, silk, cotton, nor artificial silk are damaged by silverfish. Treatment with a starch size, however, immediately renders them open to attack, and in some cases serious damage may result. It is interesting to note that artificial silk suffers much more severely than natural fibers when attacked, due apparently to it being much softer, and a good deal of damage appears to be done in tropical countries to artificial silk where starch has been used.

Silverfish are blamed for much damage not done by them but by the grubs of clothes moths or carpet beetles. For instance, of three cases sent from India of alleged damage by silverfish to wool, not one on examination supported the claim. In all three cases numerous casings of the fur moth (*Tinea pellionella*) were found, together with their excrement present showed distinctly the colors of the materials. One specimen was a union cloth, and only the wool was attacked. Another specimen of yarn contained a grub of the museum beetle (*Anthrenus museorum*), and a sloughed larval skin of the larder or bacon beetle (*Dermestes lardarius*). Both these beetles are closely akin to the carpet beetles prevalent in the United States. The larvæ of these and other species of *Dermestidae* attacking wool are commonly known in India and Iraq as woolly bear bugs. Wool mothproofed with Eulan is immune to their attacks (Clark, Jour. Soc. of Dyers and Col., 1926, *42*, 17). There is no doubt that in these three cases the main part of the damage had been done by the fur moth and the remainder by the woolly bears. Not the slightest damage could be reasonably assigned to silverfish; in fact, part of the union cloth had been sized, and so should have naturally attracted the attention of silverfish, but it was noticeably not damaged at all. What happens in such cases is that the innocent silverfish, hiding in the material from light, on being disturbed are very conspicuous, and so get blamed for the damage done by the moth grubs, which in their camouflaged cases are not readily perceived. Conversely, much of the damage they do is never connected with them. Much of the scraping they do to book backs and labels, or starched linen and collars, is put down to wear and tear (possibly the laundry!), paper falling from the walls is ascribed to damp, bad paste, or bad workmanship by the paperhangers, and so on, the damage taking place slowly over a period of time, and the culprit for the most part never being seen, and even if seen never thought of in connection with the damage it is doing.

Protection Against Silverfish Damage

Howard (*loc. cit.*) says they are readily destroyed by the free use of pyrethrum powder. Fresh buhach powder is said to be effective when frequently and persistently sprinkled (since it soon loses its efficacy) where the insect is abundant. Librarians in the United States commonly use a sweetened paste poisoned with white arsenic or corrosive sublimate as a bait. A method which in practice insures protection to the materials so guarded is to soak strips of very soft spongy, cardboard in a solution of starch and Paris green (copper aceto-arsenite). After soaking and drying they are placed around and among the materials to be protected. Their soft, easily gnawed nature provides a much more accessible and attractive feeding ground to the silverfish than the rela-

tively hard textile fabrics, book backs, and the like, so that they attack the poisoned cardboard in preference to the latter, and are killed before the goods are attacked. Paris green, however, is very poisonous to man and other animals. Naphthalene and other substances possessing low vapor tension, the smell of which is repugnant to insects (and to man), have been used precisely as for moths, and as uselessly.

In E. P. 13,071, 1909, a decoction of sweet flagroot is mixed with starch paste and a soap boiled from resin, soda crystals, naphthalene, and water. The mixture was either added to the paper pulp together with alum, or the paper or fabric was impregnated with it, dried, and treated with animal size. Though it does not specifically say so, but claims protection against all insects, it would appear to be specially directed against silverfish. It is most unlikely that it has found any practical use, even if its claims are justified.

By the incorporation of suitable amounts of Eulan (Clark and Craft, Jour. Soc. Dyers and Col., 1925, 42, 156-161) into the starch sizes, pastes, etc., used materials treated with them will not be damaged by silverfish. Eulan has no effect on the size; in fact, the use of Eulan in starch sizes is largely practised in the filling of felts and art serges, and in the sizing of worsted warps for moquettes, though there the essential use of Eulan is to render them immune to the attacks of clothes moths and carpet beetles.

I have to thank Messrs. Ernest E. Mayer, Fawsitt & Co., Ltd., of 6 Lloyds Avenue, London E. C. 3, for permission to publish this article.—A communication to the Journal of the Society of Dyers and Colorists.

Technical Notes from Foreign Sources

Using Paranitraniline Nitrosamine

It has been found that the paranitraniline nitrosamine, furnished by the Badische Company, can be printed with perfect satisfaction with the aid of beta-naphthol and thus gives a beautiful red shade, if care is taken to add small quantities of sodium aluminate and sodium zincate to the dyestuff.

It was possible to print the shade "Red H" on ordinary cloth without there being any necessity of subjecting it first to preliminary treatment.

The color, known as "Red H," is obtained from the following color compositions. The first of these compositions is known as A. It consists of 30 parts of beta-naphthol, 20 parts of sodium hydroxide of 40 deg. Be. concentration, 60 parts of sodium aluminate at 10 deg. Be. concentration, 30 parts of sodium zincate at 10 deg. Be. concentration, 40 parts of sodium sulphoricinoleate of 50 per cent concentration and 80 parts of hot water. The second composition, known as B, consists of 60 parts by weight of 50 per cent concentrated paranitraniline nitrosamine and 200 parts of hot water. The third composition, known as C, contains 60 parts by weight of a solution of sodium hydroxide at 40 deg. Be. concentration and 470 parts of gum tragancanth mixture (60-1,000). The color "Red H" is made from 260 parts each of compositions A and B, and 480 parts of composition C, making a total of 1,000 parts.

The color obtained is characterized by perfect stability. After the cloth has been printed and dried, it passes through an acid atmosphere at the ordinary or somewhat higher temperature. The acid facilitates the development of the color, such as carbonic and acetic being best for this purpose. The best results were obtained by passing the printed cloth through a chamber filled with vapors of acetic acid. (Bulletin de la Societe Industrielle de Mulhouse, 1927, pp. 165 to 166.)

Mechanism of Weighting Silk

The isoelectric point of a Japanese silk in the raw state was pH 5.1, and after weighting with tin silicophosphate, 4.1. A similar displacement of this point is obtained by prolonged treatment, first in hydrochloric acid, then in sodium hydroxide solutions equipotential with the solutions that are used in the commercial weighting process. These results appear to confirm Eloed's theory of the mechanism of this process (Berichte, 1924, 939; 1926, 216.) (Zeitschrift fuer angewandte Chemie, 1927, Vol. 40, pp. 262-264.)

Pattern Printing on Cloth with the Aid of Wax

The material that is to be printed is laid on a flat bed of wax and then printed with a heated metal templet which carries the pattern, so that the wax under the printed portions of templet melts and penetrates the material. The wax may be molded on a cylinder and the pattern carried on a cylindrical printing roller. A waxed cloth of suitable length may be used in place of solid wax. The material to be printed should be stretched at a short distance above the wax bed so that after printing it frees itself from the reserving layer and adhesion is prevented. (Austrian Patent No. 104,395.)

Cloth Dyeing for Rubber-Proofing

The precautions which are necessary in the dyeing of cloth for rubber-proofing are discussed. The pronounced tendering effect of traces of mineral acidity in materials to be hot cured and of oxalic acid in the steam cure is emphasized. The presence of minute amounts of metals

in the cloth accelerates the degradation by oxidation of the vulcanized rubber, the most common and deleterious being copper. Rubber cured by the cold process is most susceptible to traces of copper, and it is considered that cloth which contains 0.01 per cent or more of copper is useless for proofing, and thus those dyeing processes directly employing copper salts and dyeing or dye-making plant containing copper fittings are to be avoided.

Manganese is not as dangerous as copper, but it is not advisable to use the permanganate process for bleaching. The presence of grease or oil, especially in the presence of a trace of copper, has a very deleterious effect on the physical properties of the rubber, and they should not be present in amounts of more than 2 per cent. The effect of the curing processes on the dyes is discussed, and it is considered that it is almost imperative to submit sample dyeings to the actual conditions of proofing. (Journal of the Society of Dyers and Colorists, 1927, Vol. 43, pp. 105-110.)

Effect of Thickener in Calico Printing

The action of the various thickening agents that are employed in the printing of calico and cloth is still but poorly explained. It is known that the thickener has the function of absorbing the color-forming substances and maintaining them in partial suspension. Then the thickener paralyzes the capillary force of the fabric, so that the color-building substances are deposited on the surface of the cloth. Then again the thickener has the power of slowing up the various chemical reactions and transformations in such a manner that the formation of color lakes, for example, is effected much more slowly than when the transformation is effected in an aqueous solution.

Tests were made to determine the fine-capillary structure of the thickening mass. It is immaterial to the calico printer whether the hollow spaces and the capillaries in the thickening substances are characteristic of it, or whether they are first formed, whether they are of physical or chemical nature making no difference, in the course of the printing process.

Special methods had to be used in carrying out this investigation, and these methods were principally based on the formation of precipitates in the thickener mass, which can be rendered visible under the microscope in this mass. These methods must be well chosen for the reason that the principal effect that it is desirable to observe is whether or not the soluble salts, which are formed by chemical transformations, cause chemical changes to take place in the thickening substance. Then again the investigation was rendered more difficult by the fact that only such thickening masses could be put under observation as were actually employed in the printing of calicoes, etc., and hence these compositions always contained starches and gum tragacanth or also starches and other gums.

The results that have been obtained up to the present time in this investigation are given below.

Every formation of precipitate in the middle of a thickener caused a typical membrane formation within the limits of the formed precipitated. When this mass is then placed in water, then only that portion of the thickener which lies outside of the precipitate will dissolve. What remains behind is a fine, coherent membrane of comparatively great stability.

The fact that such precipitate formations occur in the majority of cases in the printing pastes that are commonly used, or else during the course of the drying of the printed color on the fabric is familiar to all. The formation of membrance, therefore, undoubtedly takes place as well on the fabric itself.

Another result of this investigation was obtained in the testing of the behavior of fine suspensions. The very finely divided Indanthrene Blue RS suspension in water was investigated. This suspension stands just at the border line of suspension and colloidal dispersion, in contradistinction with thickeners, particularly the gums. The opinion has been generally held up to the present time that the thickener acted to a certain extent as a colloidal protector. This is never the case in the form in which the thickening agent is commonly used. Quite the contrary, when such a suspension is allowed to drop on a few drops of a gum solution, a marked coagulating effect is produced in the fine pigment particles. It has also been observed, a remarkable effect, that streaky thickening of the dyestuff took place, and this resulted in the formation of characteristic figures which remained stable after a certain length of time. It may be mentioned in addition that Diamine Blue 3R, a typical colloid, when mixed with a gum thickener, shows unmistakable signs of agglutination. It is a fact that this dyestuff is converted from the ultramicroscopic into the microscopic condition.

The final question that was investigated was the manner of the distribution of the precipitate within the center of the thickening mass in order to obtain some idea of the structure. If it is assumed that honeycomb-like spaces are present, which naturally have a greater thickness of wall than of internal space, then such a structure must be betrayed by a corresponding arrangement of the particles of the precipitate. A large number of such precipitates was produced under extraordinarily different conditions, and the remaining membranes were then examined after the extraneous substances had been dissolved away. It was found that the precipitates were arranged in a net-like form, which was a replica of the structure of the thickening mass itself.

It is undoubtedly true that it is these structures which make possible the application of comparatively large amounts of liquid to the fabric during the printing process without there being any flow of these materials. (Melliand's Textilberichte, 1927, pp. 454-455.)

Sulphur Black on Linings

The use of a continuous dyeing process for coloring linings black with the aid of Sulphur Black, in place of

the discontinuous and variously disadvantageous dyeing on the jigger, has appeared to be very desirable, especially in that large quantities of fabric are dyed by this process. The non-circulating dye liquor bath was found to be very well suited for this purpose, particularly because of the simplicity of the Sulphur Black dyeing, the cheapness of the process and the fastness of the color obtained.

Just to illustrate the economy of the process, a thousand liter vat was employed which had a dyeing length of 8 meters, and the speed of the cloth through the vat was at the rate of 12 meters per minute. In order to obtain dyeings which are as uniform as possible, not only must the temperature of the liquor be maintained constant at 100 deg. Cent., but the goods must be strongly squeezed between rollers, not only during the dyeing, but at the point where it leaves the vat as well. The addition of dye liquor to the vat must be regulated in such a manner that it corresponds to the removal of dyestuff by the cloth.

The first test of eight hours' duration that was made on this vat gave such good results that it was thought advisable to try it out in a continuous process, particularly in as much as it was found that the disturbing increase of the density of the liquor due to the decrease in the proportion of sodium sulphide in it was found to be easily adjustable.

The spot test was used to determine the content of sodium sulphide in the dye liquor, this method being used for control for want of a better one. However, it was found that due to certain changes the density of the dye liquor rose very sharply and therefore an accurate volumetric method of determining the sodium sulphide in the liquor became indispensable. However, a number of tests were made with different Sulphur Blacks, and it was found that during the use of these liquors in the continuous dyeing process a steady increase took place in the density of the liquor without the sodium sulphide content of the liquor being increased in the same ratio.

From the appended tabulation it is possible to see that the increase in the density of the liquor is caused only by the increase in the salt content from the sulphur dye. When this test was repeated it was found in one case that the density of the dye liquor increased after eight additions up to 18 deg. Be., and at the same time finely divided sulphur was deposited. This sulphur was absorbed by the goods and could not be washed out from it, and after the fabric had been dried the presence of this sulphur was noticeably manifested by an intense odor of sulphur dioxide on the drying cans, and the sulphur that still remained on the dry fabric formed a very undesirable grayish coating over it.

Tests which were carried out over a period of months indicated that the first results were correct and the net conclusion was that the dyeing of fabric with the aid of sulphur dyestuffs by the continuous process is not feasible due to the decomposing action of the sulphur dyestuffs on the sodium sulphide in concentrated dye liquors. It was also indicated that a safer method is to dye on the jigger or in the stationary vat. (Melliand's Textilberichte, 1927, pp. 453-454.)

RESEARCH LABORATORY PLANNED FOR EDDYSTONE COMPANY

A modernly equipped plant laboratory will be constructed within the next few months at the Chester, Pa., mills of the Eddystone Manufacturing Company. The laboratory will comprise a special department devoted to textile research, both chemical and mechanical. The project will cost, according to official announcement, in excess of five hundred thousand dollars.

Ever since 1925, when the Eddystone Manufacturing Company was taken over by the Joseph Bancroft & Sons Company, a number of improvements have been carried out in its plants, including several additions and a thorough renovation. New equipment has been installed for the dyeing and processing of fast colors on silks and rayons.

Further improvements, it is understood, will be financed by the sale of some thirty-five acres of valuable property, with frontage on the Delaware River, now held by the Eddystone company. These improvements will include, besides the laboratory, new bulkheads and a larger boiler room, which, on completion, will make the plant one of the largest of its kind in the country.

Officers are: John Bancroft, Jr., president; Joseph Bancroft, vice-president; William T. Quillen, vice-president and general manager, and R. O. Cooke, secretary and treasurer. The firm also operates the Joseph Bancroft & Sons Company at Wilmington and a plant at Reading.

	Sulphur Black in Kilos	Sodium Sulphide in Kilos	Calcined Soda in Kilos	Turkey Red Oil in Liters	Density in Deg. Be.	Na_2S by Volumetric Method in Per Cent
800 liter original bath	14	5	1	1	4.5	0.77
200 liter addition I	14	5	1	1	7.1	1.16
200 liter addition II	14	5	1	1	8.8	1.15
200 liter addition III	14	5	1	1	10.0	1.16
200 liter addition IV	14	5	1	1	10.9	1.32
200 liter addition V	14	5	1	1	12.4	1.28

IMPORTS OF BACTERIOLOGICAL STAINS

The imports of bacteriological stains for the first six months of 1927 totaled 9,982 grams, with an invoice value of $1,044. The imports of reagents and chemicals totaled 45,624 grams, with an invoice value of $503.

Of the total quantity of bacteriological stains imported, 77 per cent came from Germany and 23 per cent from England; by value, 76 per cent came from England and 24 per cent from Germany. Of the total quantity of reagents and chemicals imported for the six months, 100 per cent—the entire amount—came from Germany.

RECEIVER FOR SUMMIT DYEING CO.

A temporary receiver has been appointed by Federal Judge Runyon for the Summit Dyeing Company, Inc., of North Bergen, N. J., in the person of John N. Platoff, of Jersey City.

This receiver has been put under $5,000 bond. The liabilities of the company are said to be $92,700, of which $38,000 is unsecured; $36,000 represents a first mortgage and other mortgages are covered by a sum in excess of $18,000. Assets, consisting of real estate, equipment and trucks, total $35,000.

The application for an equity receiver was filed by an attorney for Samuel Adler, of Brooklyn, a stockholder of the company, and the appointment of Platoff approved by John W. Ockford, of Union City, representing the defendant firm.

VOCATIONAL ANALYSIS OF GRADUATES IS MADE BY CAROLINA TEXTILE SCHOOL

The textile industry has offered better opportunities to young college men during the years since the World War than it ever did before, according to a vocational study of the textile graduates of North Carolina State College just completed by Prof. T. R. Hart of that institution. The total number of textile graduates from State College is 252, and of this number 177, or 70 per cent, are in the textile industry.

Many of those men hold good positions. Three of the textile alumni are presidents and four are managers of textile corporations, while three are general superintendents and sixteen are superintendents. There are six men holding the position of secretary-treasurer and twelve are assistant superintendents of textile corporations. Nineteen are overseers in cotton mills and dye plants and eleven are textile designers.

Dean Thomas Nelson of the Textile School says he is still receiving requests for graduates of this past year's class, although all the members of that class were placed by commencement.

Dr. E. R. Pickrell, well-known Government dye expert, who was with H. A. Metz & Co. for several years, and later with General Dyestuff Corporation, resigned from General Dyestuffs. Dr. Pickrell has purchased a wholesale and retail sporting goods store in Portland, Oreg., where he expects to reside permanently.

The rate for "Position Wanted" advertisements in this column is 2 cents a word—with a minimum of 50 cents per insertion. For all other types of advertisements—i. e., help wanted, machinery or supplies for sale—the rate is $5.00 per column inch or less per insertion.

WANTED

Salesman to represent old-established firm throughout New England and Canada, to push sales of their products consisting of Dyeing Machinery for hosiery and yarn, as well as Mercerizing Machinery. Must be a technically trained dyer and at same time be well versed mechanically. Full details in first letter. Address Box 409, American Dyestuff Reporter

INSTRUCTOR

Wanted—Ph.D. with knowledge of Textile Chemistry and Dye Application to teach and act as research associate in technical school. Address Box 412, American Dyestuff Reporter.

DYE CHEMIST

Chemist with practical experience in alizarine or vat colors is required by domestic manufacturer of these colors. Please state general qualifications, experience, age, salary desired. Address Box 413, American Dyestuff Reporter.

HOSIERY DYER

First-class hosiery dyer, experienced on all kinds of fibers and mixtures; textile school graduate; seeks connection with progressive concern. Address Classified Box 414, American Dyestuff Reporter.

UNUSUAL OPPORTUNITY

Large and prominent manufacturer of sulphonated oils, specialties, including complete line of textile products, seeks several salesmen with unusual ability and experience in this line. Salary, drawing account or commission basis. All replies treated strictly confidential. Write fully, giving age, experience, qualifications, references. Address Classified Box 415, American Dyestuff Reporter.